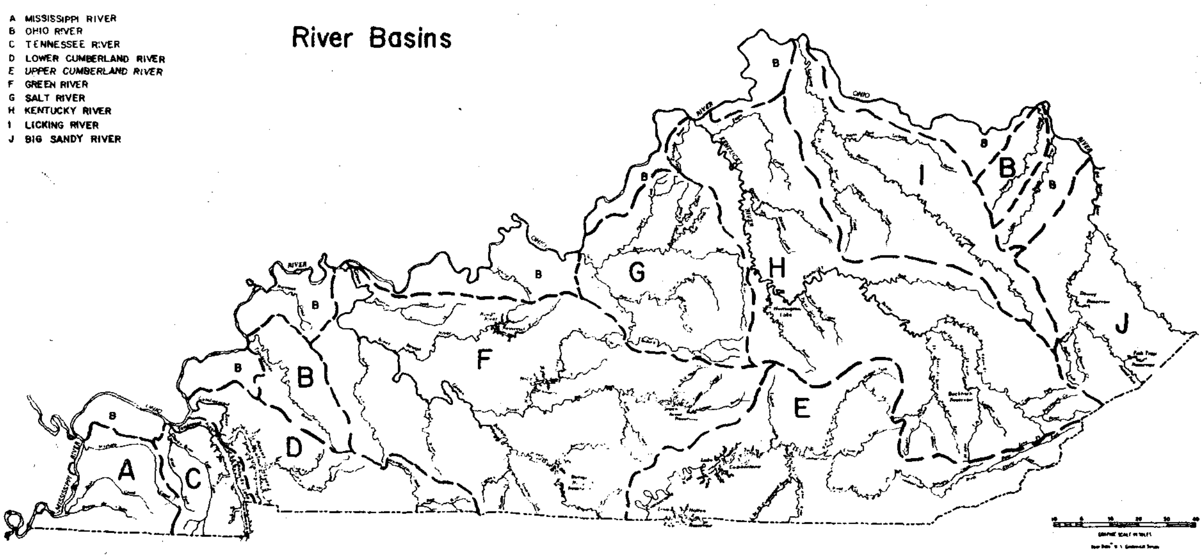
KENTUCKY WATER QUALITY REPORT TO CONGRESS



Department for Natural Resources and Environmental Protection
Division of Water (Quality)
Frankfort, Ky. 40601

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Contents

INTRODUCTION

This report is written to fulfill the requirement under PL 92-500, Section 305(b), to provide a report containing a description of the current water quality and the effects of water quality programs in Kentucky. The description is to include an indication of the extentent to which the water quality has, can and will meet the goals of this act under these programs. To this end, the Kentucky Division of Water Quality has assembled information on past and current water quality. The future water quality in Kentucky can only be predicted in general terms in anticipation of policies and decisions of local, state and federal agencies.

The information which has been compiled and is presented is an update of the 1975 "Kentucky Water Quality Report to Congress." This report consists of a re-compilation of water quality data for periods prior to January 1, 1975 and data collected during calendar year 1975. The water quality data used was collected and reported to "STORET" by the United States Geological Survey. The data was retrieved from "STORET" and summarized in charts and tables. The Kentucky Division of Water Quality data on trace elements and bacteriological analyses was also used. Information concerning point source discharges was updated from the continuing planning efforts under Section 303e. The status of municipal construction grants was updated. A new section on major lakes was added. The U. S. Army Corps of Engineers provided a summary of the projects within the three Districts in Kentucky. The Ohio River Valley Sanitation Commission prepared an assessment of the "Ohio River Main Stem" which is available for calender year 1975.

SUMMARY OF WATER QUALITY IN KENTUCKY

The quality of water in Kentucky is the result of the interactions of rain waters contacting the earth, flowing over the land, soaking into and passing through the soil, over minerals, dissolving minerals into the waters and the waters transporting materials to the streams. The materials with which water contacts on its way to a stream or lake will dictate what these waters contain once they reach a stream or lake. In-organic materials (soil constituents, calcium, sulfate, chloride, etc.) will make up the bulk of the dissolved solids and will determine a waters hardness, acidity/alkalinity and other charistics. Organic materials carried in the waters will effect to some degree the level of dissolved oxygen in the water through physical and biological processes in these waters.

As you read the different sections of this report, each written for a particular river basin, the charactistics of a river basin which have an effect on water quality will become evident. The size of a basin will determine how sensitive or insensitive to inflow and quality to change inflow and quality a river basin is. A small basin like the Salt River will react quickly to rains while a large impounded basin like Tennessee is relatively stable and slow to change.

The geology in a basin will effect the type of water produced. Within the Kentucky River Basin for example; Figure H-2 North Fork Kentucky River, (page 212) shows waters which have contacted disturbed earth in the Eastern Kentucky Coal Fields. This water is hard, high in dissolved solids, high in sulfate, high in acidity at times and high in chlorides. In contrast, the Red River, Pine Ridge in the same river basin (figure H-4, page 214) shows waters which have had few dissolved solids added, are relatively soft, have normal alkalinity and are of generally high quality.

The hydrology of each river basin has been presented. The term hydrology is used here to mean a summary of the important aspects of the amount of water which has been discharged past a measuring location on a stream. The following Table-1 will give the relative amount which eight of the ten river basins discharge during an average year.

Table I

AVERAGE DISCHARGE FROM RIVER IN KENTUCKY

OHIO RIVER	262,000 cfs
TENNESSEE RIVER	64,000 cfs
CUMBERLAND RIVER	27,500 cfs
UPPER CUMBERLAND RIVER	9,100 cfs
GREEN RIVER	11,000 cfs
SALT RIVER	3,300 cfs*
KENTUCKY RIVER	7,200 cfs
LICKING RIVER	4,150 cfs
BIG SANDY	4,450 cfs

NOTE: These are the most downstream stations in each basin.

* Sum of the two main streams, Rolling Fork and Salt River.

The population within a river basin will have an effect on streams due to the location and concentration of organic loads imposed on these streams. The population within each basin is shown in Table-2.

Table 2

POPULATION IN KENTUCKY

	BASIN	POPULATION 1970 Census	DRAINAGE AREA KENTUCKY	POPULATION DENSITY NO./ SQ.MI.
A.	Mississippi	56,637	1,250	45.3
B.	Ohio	993,001	6,090	163.1 [1]
C	Tennessee	68,412	1,000	68.4
D.	Lower Cumberland	92,380	1,900	48.6
E.	Upper Cumberland	260,000	5,077	51.0
F.	Green	426,000	8,821	48.3
G.	Salt	507,233	2,932	173 [2]
H.	Kentucky	534,000	7,033	105 [2]
I.	Licking	211,000	3,700	57.0
J.	Big Sandy	112,000	2,285	49.5
		3,261,072	40,088	81.3

Propulation greater than 50,000

1 *Louisville, Owensboro*

2 *Lexington*

The point source loads on streams which are predicted to depress the dissolved oxygen below 5.0 mg/l as a result of the population distribution within each basin is shown in Table-3. This table shows the effect of all treated effluents on streams in Kentucky in relation to the predicted dissolved oxygen content during design flows. It is shown by this table that the municipalities in Kentucky contribute 35 percent, the industries contribute 7 percent, and that small discharges contribute 58 percent of the organic point source loads which may cause the dissolved oxygen to be less than 5.0 mg/l in Kentucky streams.

Table 3

POINT SOURCE LOADS* IN KENTUCKY STREAMS

	BASIN	STREAM MILES STUDIED	DISSOLVED OXYGEN PREDICTED LESS THAN 5.0 MG/L			
			TOTAL MILES	MUNICIPAL	INDUSTRIAL	OTHER
A.	Mississippi	275	84	13	26	45
B.	Ohio	431	85	36	8	41
C.	Tennessee	248	59	15	14	30
D.	Lower Cumberland	360	62	40	0	22
E.	Upper Cumberland	752	167	25	0	151
F.	Green	1,670	214	173	6.8	34.5
G.	Salt	596	160	61	8	91
H.	Kentucky	868	145	119	0	26
I.	Licking	1,000	384	89	46	249
J.	Big Sandy	560	250	10	5	235
		6,760	1,609	570	114	925

* 1975 Wasteload Allocation from 303e River Basin plans.

There are 181 construction grants either underway or pending in Kentucky for municipal wastewater control. Of these 181, 161 are Step I 's (evaluations), 9 Step II's (design) and 11 Step III's (construction). During the last year, there were 8 plants which were given final approval on completed construction. This completed construction improved approximately 20 miles of Kentucky streams. Table 4 is a summary of the grant status in Kentucky. Each river basin section contains a list of the facilities receiving grants.

Table 4

SUMMARY OF GRANTS TO MUNICIPALITIES IN KENTUCKY

BASIN		Step I	Step II	Step III
A.	Mississippi	7	0	0
B.	Ohio	33	2	3
C.	Tennessee	5	0	0
D.	Lower Cumberland	7	0	1
E.	Upper Cumberland	21	1	0
F.	Green	27	0	1
G.	Salt	9	3	2
H.	Kentucky	30	1	2
I.	Licking	14	2	2
J.	Big Sandy	8	0	0
		161	9	11

NOTE: These are pending and projects underway.

Table 5 shows the municipal dollar needs estimated in 1974 by category in order that cities in Kentucky may meet water quality criteria and growth expectations.

Table 5

1974 NEEDS SURVEY

	1974 Needs Thousands Dollars
Category I Secondary Treatment	54,751
Category II Advanced Treatment	294,166
Category 111 A Inflow/Infiltration Correction	62,743
Category III B Major Sewer System Rehabilitation	84,181
Category IV A New Collectors	543,749
Category IV B New Interceptors	412,632
Category V Correction of Combine Sewer Overflows	706,559
Category VI Treatment and/or control of Stormwaters	2,052,631
Total Needs	4,211,412

The trace chemical water quality was compared to standards set by Kentucky in relation to health and public water supplies and to proposed Environmental Protection Agency standards. The waters which did not meet these standards are in areas of coal mining. The streams were Tradewater River, Olney (iron greater than 300 mg/l), and Pond River near Sacramento (flouride greater than 1.0 microgram/liter).

The Division of Water instituted bacteriological monitoring at selected public water supply treatment facilities in FY74. The data from this program is presented in the water quality data tables. Since the period of record is only two years, no concrete conclusions have been drawn from the data at this time. A preliminary cursory look at this data indicates that the coliform bacterial (Total and Fecal) are high in relation to the state criteria. A simple arithmetic mean of all total coliform data gives a result of 2,600 colonies per 100 ml statewide. This represents 644 observations of which 263 were greater than the standard or 41 percent exceedance (see Table 6).

When this recreational standard was exceeded or expected to be exceeded, a determination of fecal coliform was made (see Table 7). Table 7 shows that of 238 observations of fecal coliform, 90 were greater than 400 colonies per 100 ml. or 38 percent. The sixth annual report of the Council on Environmental Quality on page 361, Table 18 shows that 67 percent of the analyses for fecal coliform exceeded the recreation criterion. The arithmetic average of fecal coliform analyses in Kentucky was 85 colonies per 100 ml of stream water analyzed.

A copy of Kentucky's current regulation 401 KAR 5:025 is included here for your reference in comparing specific quality conditions reported to the current standards. These standards also appear in each data section of the river basin reports for each parameter reported.

Department for Natural Resources
and Environmental Protection
Bureau of Environmental Quality
Division of Water Quality

401 KAR 5:025. Water quality standards.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 13.082, 224.033(17)
SUPERSEDES: WP-4-1
NECESSITY AND FUNCTION: This regulation is to implement KRS 224.020. The regulation provides narrative water quality standards for all waters and sets forth a use classification scheme with numeric criteria for applicable waters.

Section 1. Prohibitions. No person or group of persons as defined in KRS Chapter 224 shall cause to be violated any one of the minimum standards in Section 2 or any one of the standards established in Sections 3 to 9 of this regulation.

Section 2. The following are minimum conditions applicable to all waters of the Commonwealth of Kentucky. All waters of the Commonwealth shall be:

(1) Substantially free from substances attributable to municipal, industrial or other discharges or agricultural practices that will settle to form putrescet sludge deposits;

(2) Free from floating debris, oil, scum and other floating materials attibutable to municipal, industrial or other discharges or agricultural practices in amounts sufficient to be unsightly or deleterious;

(3) Free from materials attributable to municipal, industrial, or other discharges or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance; and

(4) Free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

(5) In the standards established by subsections (1) to (4), every person as defined in KRS Chapter 224 shall remove from their discharges those substances described in subsections (1) through (4) to the lowest practicable level attainable under current technology.

Section 3. Stream use classification. In addition to the minimum conditions set forth in Section 2, the use classification found in Sections 4 to 9 shall fovern where applicable.

Section 4. Public water supply and food processing industries. The following criteria are applicable to surface water at the point at which water is withdrawn for use for a public water supply or by a food processing industry:

(1) Bacteria: Coliform group shall not exceed 5,000 per 100 ml as a monthly arithmetical average value as determined by either MPN or MF count nor exceed this number in more than twenty percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples.

(2) Threshold-odor number after normal treatment shall not be less than three.

(3) Dissolved solids shall not exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time. Values of specific conductance of 800 and 1.200 micromhos/cm, at 25 degrees Centigrade, amy be considered equivalent to dissolved solids concentrations of 500 and 750 mg/l.

(4) Radioactive substances: Gross beta activity shall not exceed 1,000 picocuries per liter, pCi/l, nor shall activity from dissolved Strontium 90 exceed 10 pCi/l, nor shall activity from dissolved alpha emmitters exceed 3 pCi/l,

(5) Chemical constituants shall not exceed the following specified concentrations at any time:

Constituents	Concentrations, mg/l
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (Hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

Section 5. Industrial water supply. The following criteria are applicable to water at the point at which water is withdrawn for use, either with or without treatment, for industrial cooling and processing, other than food processing, and shall be applicable only within a mixing zone:

(1) pH shall not be less than 5.0 nor greater than 9.0 at any time.

(2) Temperature shall not exceed 95 degrees Fahrenheit at any time.

(3) Dissolved Solids shall not exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time. Values of specific conductance of 1,200 and 1,600 micromhos/cm, at 25 degrees Centigrade, may be considered equivalent to dissolved solids concentrations of 750 and 1,000 mg/l.

Section 6. Aquatic life. The following criteria are fo. evaluation of conditions for the maintenance of well balanced, indigenous fish population. The aquatic use standards shall not apply to areas immediately adjacent to outfall. Areas immediately adjacent to outfalls shall be as small as possible, be provided for mixing only, and shall not prevent the free passage of fish and drift organisms.

(1) Dissolved oxygen. Concentrations shall average at least 5.0 mg/l per calendar day and shall not be less than 4.0 mg/l at any time or any place outside the mixing zone.

(2) pH values shall not be less than 6.0 nor more than 9.0.

(3) Temperature shall not exceed 89 degrees Fahrenheit.

(a) There shall be no abnormal temperature changes that may effect aquatic life unless caused by natural conditions.

(b) The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

(c) The maximum temperature rise at any time or place above natural temperatures shall not exceed 5 degrees Fahrenheit in streams. In addition, the water temperature for all streams shall not exceed the maximum limits indicated in the following table:

Stream maximum temperature for each month in °F.

January	50
February	50
March	60
April	70
May	80
June	87
July	89
August	89
September	87
October	78
November	70
December	57

(d) The allowable temperature increase in public water impoundments shall be limited to 3 degrees Fahrenheit in the epilimnion if thermal stratification exists. Public water impoundments include all impounded water of the Commonwealth which are open to the public and used by the public.

(4) Toxic substances shall not exceed one-tenth of the 96-hour median tolerance limit of fish. Where there are substances that are toxic because of their cumulative characteristics, other limiting concentrations may be used in specific cases as presently approved by the Federal Environmental Protection Agency, or as later adopted by the Division of Water Quality.

Section 7. Put-and-take trout streams: The following criteria are applicable to those waters designated by the division as put-and-take trout streams:

(1) Dissolved oxygen concentrations shall not be less than 6.0 mg/l at any time or any place. Spawning areas, during the spawning season, shall be protected by a minumum DO concentration of 7.0 mg/l.

(2) Temperature: Stream temperatures shall not be increased artificially above the natural temperature at any time in cold water trout streams.

Section 8. Recreation: Unless caused by natural conditions, the following criterion shall apply in waters to be used for recreational purposes, including but not limited to such water-contact activities as swimming and water skiing. Bacteria: The total coliform level shall not exceed an average 1,000 per 100 ml. Total coliform shall not exceed this number in twenty percent of the samples in a month, nor exceed 2400/100 ml on any day. If the level of total coliform is exceeded, then a fecal coliform standard shall be used. There shall be a reduction of fecal coliform to such degree that during the months of May through October fecal coliform density in the discharge does not exceed 200 per 100 ml as a monthly geometric mean, based on not less than ten samples per month, nor exceed 400 per 100 ml in more than ten percent of the samples examined during a month, and not exceed 1,000 per 100 ml as a monthly geometric mean, based on not less than ten samples per month, nor exceed 2,000 per 100 ml in more than ten percent of the samples examined during a month.

Section 9. Agricultural: No criteria in addition to the minimum conditions enumerated in Section 2 are proposed for the evaluation of stream quality at the point at which water is withdrawn for agricultural and stock watering use.

Section 10. Multiple uses. One or more uses established in Sections 4 to 9 may apply to the same waters. The use criteria shall apply to those waters suitable for use or uses provided in Section 3. In the event there is a conflict between or among the applicable uses, the more stringent use criteria shall apply.

Table 6

TOTAL COLIFORM DATA FOR KENTUCKY

This data appears in the appropriate basin data summary.

Sta.	OBS	No.> 1,000	Average	Colonies/100 ml. Minimum	Max.	DATE Beg.	End.
2	21	15	6895	8	67000	750106	751218
3	8	8	7387	2000	15000	750219	751030
6	19	13	2795	10	10000	750106	751239
7	11	6	3345	648	18267	750130	751223
8	12	11	4306	217	11200	750107	751215
10	12	6	1854	0	4600	750107	751215
14	11	11	12968	1900	38000	750213	751111
16	14	0	159	0	745	750106	751204
17	14	0	87	0	560	750106	751204
18	10	2	681	80	3400	750211	751111
19	11	11	5909	1400	31000	750213	751111
20	12	1	476	41	1600	750121	751223
22	18	9	2240	3	14800	750106	751218
23	12	3	975	0	4167	750108	751218
24	13	0	182	0	800	750106	751204
27	12	0	262	5	800	750107	751217
28	12	4	1402	15	7400	750107	751215
29	11	1	211	0	1160	750107	751216
33	11	9	9160	0	31000	750212	751117
36	11	3	1605	98	7800	750107	751217
37	12	4	1147	0	7400	750107	751215
38	13	11	3581	786	10200	750107	751215
39	11	9	2081	233	6500	750107	751215
41	11	4	1335	0	6550	750108	751218
42	12	3	786	4	3300	750107	751217
43	11	0	87	0	400	750107	751216
45	11	4	1254	25	4700	750107	751216
46	6	3	2788	115	11000	750731	751217
47	12	0	310	16	933	750108	751215
49	21	18	9561	11	33750	750106	751219
50	19	13	7575	250	63600	750106	751218
51	18	10	3307	50	20800	750106	751218
52	18	10	2102	77	6700	750106	751219
53	20	13	5220	97	50400	750106	751219
54	13	0	251	0	482	750106	751204
56	13	0	210	0	484	750106	751204
57	12	0	14	0	60	750127	751204
58	13	0	190	26	800	750106	751204
59	14	0	196	0	500	750106	751204
60	14	0	169	0	488	750106	751204
61	12	1	302	10	2900	750130	751223
62	11	1	470	69	1600	750121	751223
63	11	1	409	0	1600	750121	751223
64	11	2	554	4	1600	750121	751223
65	12	1	322	0	1600	750121	751223
66	11	7	22193	32	190000	750130	751217
70	11	5	5278	100	28000	750130	751217
90	9	8	26826	800	140000	750226	751117
96	7	6	13681	10	65000	750219	751030
155	20	17	3992	10	16800	750106	751218

644 263

41 percent greater than 1,000 colonies/100 ml.

Table 7

Fecal coliform data for Kentucky.

This data appears in the appropriate basin data summary.

Sta.	OBS	No. > 400	Average	Colonies/100 ml. Minimum	Max.	DATE Beg.	End.
2	11	6	396	0	880	750218	751218
3	5	5	830	450	1220	750219	750730
6	12	6	1779	48	16100	750324	751239
7	7	1	304	83	200	750530	[illegible]
8	7	5	1514	102	6332	750421	751215
10	7	2	328	0	620	750421	751215
14	6	4	693	300	1200	750213	[illegible]
16	4	0	58	3	140	750106	750218
17	4	0	12	1	20	750106	750218
18	4	0	90	0	300	750211	[illegible]
19	6	3	635	160	1700	750213	750728
22	8	3	574	84	2100	750325	751218
23	3	1	511	0	1303	750722	751218
24	4	0	17	5	50	750106	750218
27	1	0	344	344	344	751022	751022
28	1	1	3780	3780	3780	751215	751215
33	7	4	770	50	1515	750212	750813
36	2	1	1553	73	3033	751022	751125
37	3	1	314	53	600	751022	751215
38	6	3	310	0	600	750519	751215
39	6	2	348	73	800	750721	751215
41	5	4	1558	139	3900	750624	751218
42	1	0	267	267	267	751022	751022
45	3	1	409	250	587	750722	751125
46	5	2	1622	200	6700	750826	751217
49	10	7	1291	56	3200	750417	751219
50	8	6	1296	137	3700	750507	751218
51	9	3	1249	4	8100	750324	751218
52	9	1	254	48	1100	750415	751219
53	9	3	1272	54	9533	750612	751219
54	4	0	39	4	104	750106	750218
56	3	0	5	0	11	750127	750218
57	4	0	34	0	126	750106	750218
58	5	0	50	1	160	750106	750512
59	4	0	29	8	67	750106	750218
60	4	0	27	11	65	750106	750218
62	1	0	49	49	49	750910	750910
63	1	0	70	70	70	750910	750910
64	1	0	96	96	96	750910	750910
66	9	5	3978	0	14000	750514	751217
70	8	1	945	0	6233	750515	751217
90	7	4	9965	20	53000	750212	751030
96	5	3	5256	0	24000	750219	750730
155	9	2	309	30	800	750507	751218
	238	90					

38 percent of all observations were greater than 400 colonies/per 100 ml.

Lakes Summary

This section represents that portion of the Water Quality Strategy in Kentucky which addresses lake water quality. It is intended as an extension of the Inventory of Lakes section in the Division of Water Quality 1974 Program Plan which is presented on the following page. The U.S. Army Corps of Engineers, as a participant in the coordinated water quality monitoring effort in Kentucky, has submitted water quality summaries for their fourteen major projects in the state. Table 1 presents a brief outline of the contents of these summaries. In addition, Table 2 presents a summary of water quality conditions at the fifteenth federal impoundment, Kentucky Lake, and a major private impoundment, Herrington Lake. The Kentucky Lake and Herrington Lake summaries were developed on the basis of limited water quality data obtained from the Tennessee Valley Authority and the Kentucky Department of Fish and Wildlife, respectively. On the basis of total area, the sixteen lakes summarized in this section represent 95 percent of the lake surface area in the state of Kentucky. Following the presentation of the Corps of Engineers lake reports is a glossary of general terms used within this section.

State of Kentucky

INVENTORY OF LAKES

	Federal USCE	S.C.S. State Municipal	Private
Total number of publicity owned fresh water lakes in the state	15	153	122
Total number of significant lakes			
Number of significant lakes exhibiting noticeable eutrophy			
Number of significant lakes exhibiting no noticeable eutrophy			
Number of significant lakes for which eutrophication status is not known E. G., data is not readily available to make a determination of its eutrophic status.			
Total area of publicly owned fresh water lakes	313,961	10,109	5,830
Total area of significant lakes			
Area of significant lakes exhibiting noticeable eutrophy			
Area of significant lakes exhibiting no noticeable eutrophy			
Area of significant lakes for which eutrophication status is not known.			

1. Federal-4 of 15 were a part of the National Eutrophication Survey none of the lake exhibited noticeable eutrophy.

2. Soil Conservation Service, State & Municipal — Most are used for public water supply, are small to moderate in size (20 to 850 acre) and the cities treat the lakes for algae control which precludes a judgment on the Eutrophic status.

3. Private (excludes Herrington Lake 2940 acres owned by Kentucky Utilities). Many lakes are for fee fishing, a few for water supply. Some lakes have public access and are developed with summer cottages. The fishing lakes would tend to a mesoeutrophic or eutrophic status because of artificial fertilization.

TABLE L-1a

WATER QUALITY SUMMARY OF THE MAJOR U. S. ARMY CORPS OF ENGINEERS PROJECTS IN KENTUCKY

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
MARTINS FORK LAKE	NASHVILLE	Under Construction	Evaluation of water temperature data collected by U.S.G.S. will define the natural seasonal temperature regime.	Data base to be established after project completion.	Preimpoundment water quality data shows an increase in turbity levels and metals concentrations in Martins Fork.
LAUREL LAKE	NASHVILLE	1974	Typical of tributary type impoundment in the region.	Low hypolimnion dissolved oxygen, probably due to decay of organics in the recently impounded project. Trends in Hypolimnion dissolved oxygen to be monitored.	None Listed
LAKE CUMBERLAND	NASHVILLE	1950	Typical of tributary type impoundment in the region, however, all layers may not undergo complete mixing during winter.	Relatively low hypolimnion dissolved oxygen though not as severe as in similar projects.	Excessive turbidity in lower regions of lake.
DALE HOLLOW LAKE	NASHVILLE	1943	Typical of tributary type impoundment in the region.	Hypolimnion dissolved oxygen approaches zero near lake bottom in the fall.	None Listed
LAKE BARKLEY	NASHVILLE	1964	Does not stratify due to high current velocities in the upper reaches and low storage volume versus flow relationship.	Due to thermal stratification pattern, no significant dissolved oxygen problems exist, though isolated oxygen sags have been reported.	None Listed

TABLE L-1a
Continued

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
CAVE RUN LAKE	LOUISVILLE	1973	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
NOLIN RIVER LAKE	LOUISVILLE	1963	Typical of tributary type of impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Moderated dissolved phosphorus concentration.
BARREN RIVER LAKE	LOUISVILLE	1964	Typical of tributary type of impoundment in the region.	Dissolved oxygen stratification develops with thermal stratification. Low hopolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
BUCKHORN LAKE	LOUISVILLE	1960	Typical of tributary type of impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hopolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
GREEN RIVER LAKE	LOUISVILLE	1969	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.

TABLE L-1a
Continued

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
ROUGH RIVER LAKE	LOUISVILLE	1959	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
DEWEY LAKE	HUNTINGTON	1950	Weak stratification during the summer.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Excessive levels of turbidity. High levels of iron and manganese correlating with high inflow leve Occasional high mercury concentrations.
FISHTRAP LAKE	HUNTINGTON	1968	Weak stratification during the summer.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Excessive levels of turbidity. High levels of iron and manganese correlating with high inflow level Occasional high mercury levels in inflow and outflow.
GRAYSON LAKE	HUNTINGTON	1968	Typical of tributary type impoundment in the region.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolve oxygen near lake bottom. Outflow dissolved oxygen high due to high-level releases and stilling basin reaeration.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Occasional high mercury levels.

NOTE: Biological Survey Attached

TABLE L-1b

WATER QUALITY SUMMARY OF THE MAJOR U. S. ARMY CORPS OF ENGINEERS PROJECTS IN KENTUCKY

PROJECT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
MARTINS FORK LAKE	Coal Mining Project related relocation work.	Possible water quality degradation due to mining activities or project relocation work.	Future efforts include expanded sampling, installation of automatic monitoring system, and preparation of project operation manual.
LAUREL LAKE	Project power generation in Fall of 1976. Future tailwater trout fishery.	Tailwater trout stocking program may have to be delayed until a means is found to alleviate poor quality releases from oxygen depleted hypolimnion.	Future efforts include expanded sampling and studies to find a means to alleviate the problem of poor water quality releases.
LAKE CUMBERLAND	Project power releases Tailwater trout fishery	Release of turbid water in lower regions of the lake causes water in the tailwater and downstream points to appear murky.	Future efforts include a complete evaluation of all available water quality data, a better definition of inflow quality, a definition of withdrawal zone produced by power releases, and a study of reaeration by turbulence in the tailrace.
DALE HOLLOW LAKE	Coal Mining Project power releases Tailwater trout fishery	Low dissolved oxygen hypolimnetic releases create concern for tailwater trout fishery. Water quality degredation due to mining activities in the watershed particularly in the East Fork, Obey River drainage.	Future efforts include a complete evaluation of all available water quality data, a better definition of inflow quality, a definition of the withdrawal zone produced by power releases, and a study of reaeration by turbulence in the tailrace.
LAKE BARKLEY	Project power releases	No significant adverse impacts with the exception of isolated oxygen sags.	Future efforts include a study of the monitoring deficiencies and adjustment of strategy for monitoring.

TABLE L-1b
Continued

PROJECT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
CAVE RUN LAKE	Strip Mining Oil & Gas Wells Salyersville & West Liberty Sewage Treatment Plants	Minor water quality degradation due due to strip mining. No discernable effect from oil and gas wells in upper reaches. Negligible effect from sewage treatment plants. Problems created at Morehead Water Treatment Plant, 1 mile below dam due to poor quality releases.	Influent water quality rated as generally good, but showing some effects of strip mining. Future efforts include a study of feasible structural modifications to outlet works to eliminate releasing hypolimnetic waters.
NOLIN RIVER LAKE	Agriculture Elizabethtown & Hodgenville Sewage Treatment Plants. Tailwater Trout Fishery.	Minimal effect from sewage treatment plants. No nuisance algae blooms caused by relatively high nutrient levels produced by agricultural activity.	Influent water quality rated as relatively good.
BARREN RIVER LAKE	Oil Wells Glasgow Sewage Treatment Plant Tailwater trout fishery	No discernable effect from oil wells in upper reaches. Deleterious effects (low dissolved oxygen, algae blooms, odors, etc.) on Beaver Creek arm of lake caused by Glasgow Sewage Treatment Plant.	Influent water quality rated as generally acceptable with the exception of Beaver Creek.
BUCKHORN LAKE	Strip Mining Hyden Sewage Treatment Plant Tailwater trout fishery	Minor water quality degradation due to strip mining. Isolated algae blooms caused by occasional bypasses at Hyden Sewage Treatment Plant.	Influent water quality rated as acceptable, but altered somewhat from natural conditions by strip mining.

TABLE L-1b
Continued

PROJECT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
GREEN RIVER LAKE	Liberty Sewage Treatment Plant Tailwater Trout Fishery	Negligible effect from Liberty Sewage Treatment Plant.	Influent water quality rated as excellent, having been only slightly altered from natural conditions.
ROUGH RIVER LAKE	Agriculture Tailwater Trout Fishery Leitchfield Municipal Water intake.	No nuisance algae blooms caused by nutrients produced by agricultural activity. Problem at Leitchfield Water Plant alleviated by switching from deepest intake to shallowest intake during stratification.	Influent water quality rated as relatively good.
DEWEY LAKE	Coal Mining	Degradation of water quality due to coal mining, resulting in excessive sedimentation and metals concentrations with possibility of adverse effects on the pH regime in the near future. Severe hydrogen sulfide odors in stilling basin produced in the oxygen depleted hypolimnion.	Lake water quality rated as poor to degraded. Future efforts include intensified monitoring of the effects of coal mining, and monitoring of mercury concentration.
FISHTRAP LAKE	Coal Mining Tailwater Trout Fishery	Degradation of water quality due to coal mining, resulting in excessive sedimentation and metals concentrations with possibility of adverse effects on the pH regime in the near future.	Lake water quality rated as degraded to severely degraded Future efforts include intensified monitoring of the effects of coal mining.
GRAYSON LAKE	Coal Mining Tailwater Trout Fishery	No significant adverse impact on water quality by mining activities at this time.	Lake water quality rated as fair to good. Future efforts include monitoring programs focused at both inflow and lake stations, and cooperative studies and regulatory effort with the State of Kentucky and other appropriate agencies.

TABLE L-2a

WATER QUALITY OF OTHER MAJOR LAKES IN KENTUCKY

IMPOUNDMENT	GOVERNING AGENCY	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
KENTUCKY LAKE	TENNESSEE VALLEY AUTHORITY	1944	Pattern similar to Barkley Lake. Some period of weak stratification.	Due to thermal stratification pattern, no significant dissloved oxygen problems exist	No excessive concentrations of trace elements with the exception of ocasional high levels of manganese.
HERRINGTON LAKE	KENTUCKY UTILITIES	1925	Typical of tributary type impoundment in the region.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Ranges of pH and alkalinity indicative of high buffering capacity of watershed. Occasional hydrogen sulfide odors occurring in low dissolved oxygen level of primary oxycline.

TABLE L-2b

WATER QUALITY OF OTHER MAJOR LAKES IN KENTUCKY

IMPOUNDMENT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
KENTUCKY LAKE	Project Power generation Phosphate mining on Duck River.	No significant adverse impacts on water quality by phosphate mining on Duck River or other activities in upper reaches.	Lake water quality rated as excellent. Future efforts include continued monitoring by Tennessee Valley Authority and related agencies.
HERRINGTON LAKE	Project Power Generation.	No significant adverse impacts on water quality at this time.	Future efforts include expanded monitoring in order to broaden the data base.

ACKNOWLEDGEMENTS

Data for this report was assembled from the following sources:

United States Geological Survey water quality data as retrieved through the "STORET" information system.

"Water Resources Data for Kentucky, Water Year 1975", U. S. Geological Survey Water-Data Report KY-75-1.

United States Army Corps of Engineers, Huntington District, Louisville District, and Nashville District

United States Department of Agriculture, Soil Conservation Service, Lexington, Kentucky.

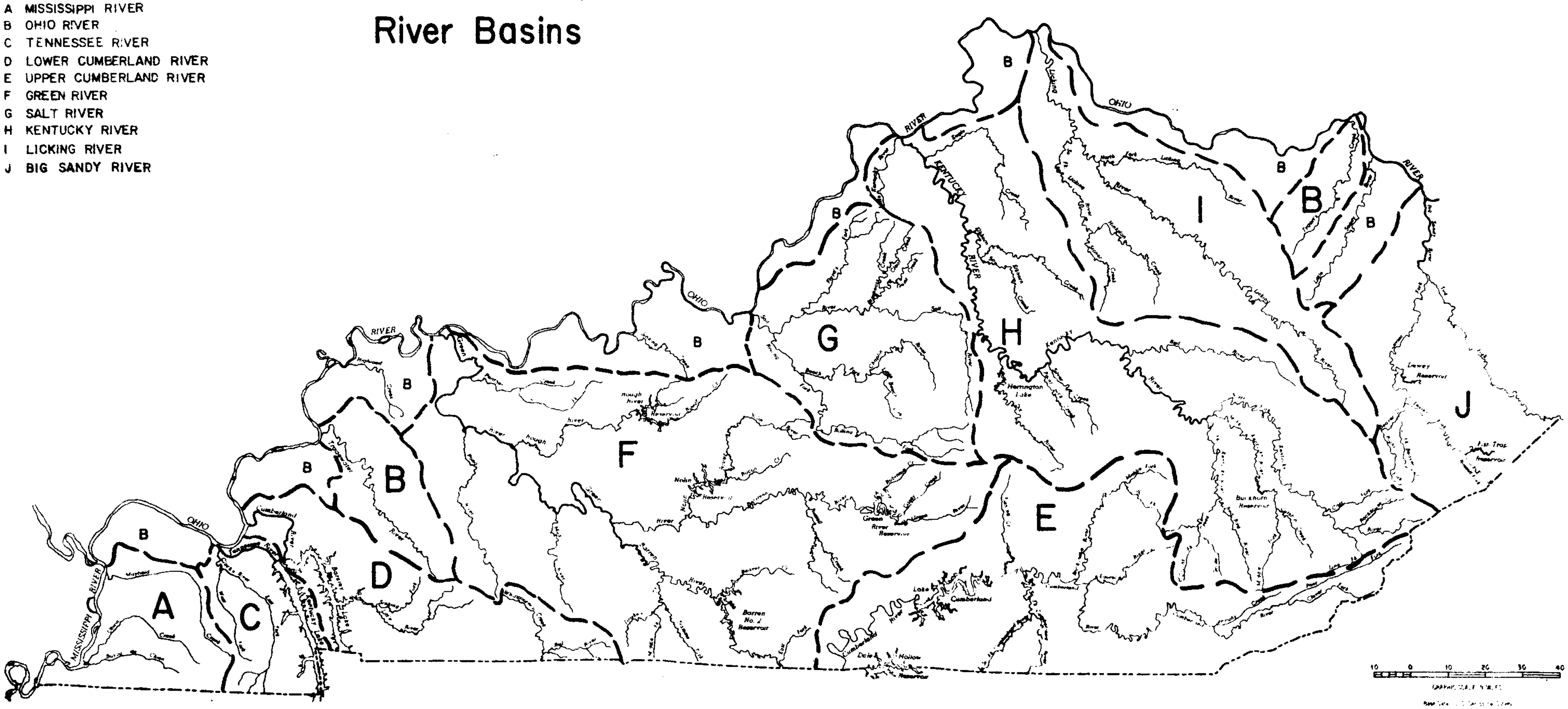
Kentucky Department of Fish & Wildlife Resources.

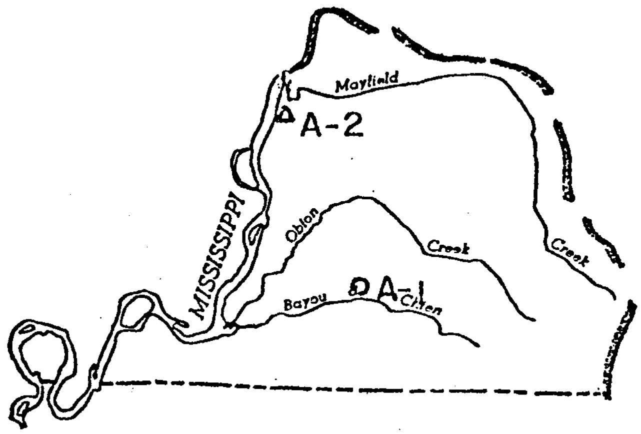
Kentucky Department for Natural Resources and Environmental Protection, Division of Water Quality

Ohio River Valley Sanitation Commission, Cincinnati, Ohio.

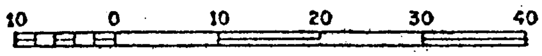
A MISSISSIPPI RIVER
B OHIO RIVER
C TENNESSEE RIVER
D LOWER CUMBERLAND RIVER
E UPPER CUMBERLAND RIVER
F GREEN RIVER
G SALT RIVER
H KENTUCKY RIVER
I LICKING RIVER
J BIG SANDY RIVER

River Basins





MISSISSIPPI RIVER



GRAPHIC SCALE IN MILES

Base Data: U. S. Geological Survey

THE MISSISSIPPI RIVER BASIN

The portion of the Mississippi River Basin in Kentucky makes up approximately one half of an area in the far western corner of the State called the Jackson Purchase region (named after General Andrew Jackson who, in 1818, arranged the purchase treaty with the Chickasaw Indians). The Jackson Purchase region is unique in many respects from the rest of Kentucky. This report will discuss first the Mississippi River Basin in general in the region, and secondly discuss existing water quality in the area and the factors that influence water quality in the basin.

I. Basin Description

A. Geography

The Mississippi River forms the western boundary of the Commonwealth of Kentucky from the confluence of the Ohio River at Cairo, Illinois to the Tennessee border. The Mississippi enters Tennessee and in reversing direction, a small area of Kentucky is thus formed and known as the New Madrid Bend.

This basin contains all or portions of the following counties: Ballard, Carlisle, Hickman, Fulton, Graves, McCracken and Calloway and encompasses a total drainage area in Kentucky of approximately 1,250 square miles (Table A-1). Several streams are tributary to the Mississippi River, with their respective areas in Kentucky shown in square miles in parenthesis following the names of the tributaries. They are: Mayfield Creek (438.0), Obion Creek (319.0), Bayou du Chien (214.0), and Obion River (146.0). An additional 138.0 square miles are directly tributary to the Mississippi River.

B. Topography

The topography of the basin is such that the headwater areas in the watersheds are hilly, resulting in severe sand and soil erosion problems. However as the land approaches the Mississippi River it becomes gently rolling, ending abruptly in a flat flood plain. Elevations vary from 267 to 560 feet above sea level, with average major tributary slopes ranging from approximately 4.0 to 7.0 ft./mi. The main stem of the Mississippi has an average slope in this area of 0.33 ft./mi.

C. Geology

The geology in this area represents four major formation types, made up of sand, clay, gravel, and silt in varying amounts. These are situated on a bedrock composed of limestone, chert, and dolomite. Surface waters are given a bicarbonate hardness by this limestone bedrock. Groundwater from this area is generally quite good, although some problems occur depending upon the formation from which it is drawn. Water hardness, pH, and high iron content are the major groundwater problems. The high iron content is encountered most frequently when water is drawn from the bedrock of the area. However, due to the constancy of water quality, temperature, and yield (as high as 1,700 gallons per minute) groundwater remains the major source of domestic and industrial water supply in the Mississippi region.

D. Hydrology

The Mississippi River itself is, of course, one of the most important rivers in the world as it relates to commercial barge traffic. It is under the jurisdiction of the U. S. Corps of Engineers for the maintenance of navigation and flood control. A series of locks and dams and upland storage upstream of St. Louis, along with channel maintenance assure a channel depth of 12 feet from the mouth to the confluence of the Ohio River by maintaining pools and augmenting low flows.

Tributaries to the Misssissippi River in Kentucky (excluding the Ohio River), although equipped with flood retarding structures, are not flow regulated or is the flow augmented by dams and reservoirs. Surface water flows, recorded at gauging stations situated along each major tributary give a picture of the hydrology in the region. The flows are listed in Table A-6 on the following page.

The natural low flow in each of these three tributaries is above the average for comparable sized drainage basins in Kentucky. Bayou de Chien has the highest natural low flow in this area of the Mississippi Basin, due to the groundwater contribution to the surface water flow. The groundwater contribution improves water quality in the area due to the greater quality of water available for dilution wasteloads.

E. Population

The total population (1970) in the Mississippi River Basin in Kentucky numbers 56,637. Mayfield, Kentucky in Graves County, with a population of 10,600 has the largest population in the basin. Ten smaller communities make up the rest of the urban population of 21,380 which represents 38 percent of the total population. Columbus, Kentucky, a community of 371 people, is the only unsewered community in the basin. The remainder of the population is located in rural area. The urban distribution is shown in Table A-3. Population in a basin is an important factor in the water quality of the basin, as water is used for a great variety of purposes, then discharged back into the streams.

TABLE A-6

SURFACE WATER RECORDS FOR THE MISSISSIPPI RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Mayfield Creek at Lovelaceville	wtr/yr 1975**	212 sq.mi.		15,900 cfs, 75 cfs* / sq.mi.		7.9 cfs
Obion Creek at Pryorsburg	wtr/yr 1975***	36.8 sq.mi.		6,030 cfs, 164 cfs / sq.mi.		
Bayou de Chien near Clinton	36 yr.	68.7 sq.mi.	97.2 cfs, 1.4 cfs / sq.mi.	9,460 cfs, 138 cfs / sq.mi.	4.0 cfs, 0.1 cfs / sq.mi.	6.3 cfs
	wtr/yr 1975		235 cfs, 3.4 cfs / sq.mi.	4,960 cfs, 72 cfs / sq.mi.	13 cfs, 0.2 cfs / sq.mi.	

* Cubic feet per second

** Operated as a continuous-record gaging station 1938-72. and as a crest-stage partial-record station since 1973

*** Operated as a continuous-record gaging station 1952-65, and as a crest-stage partial-record station since 1974.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

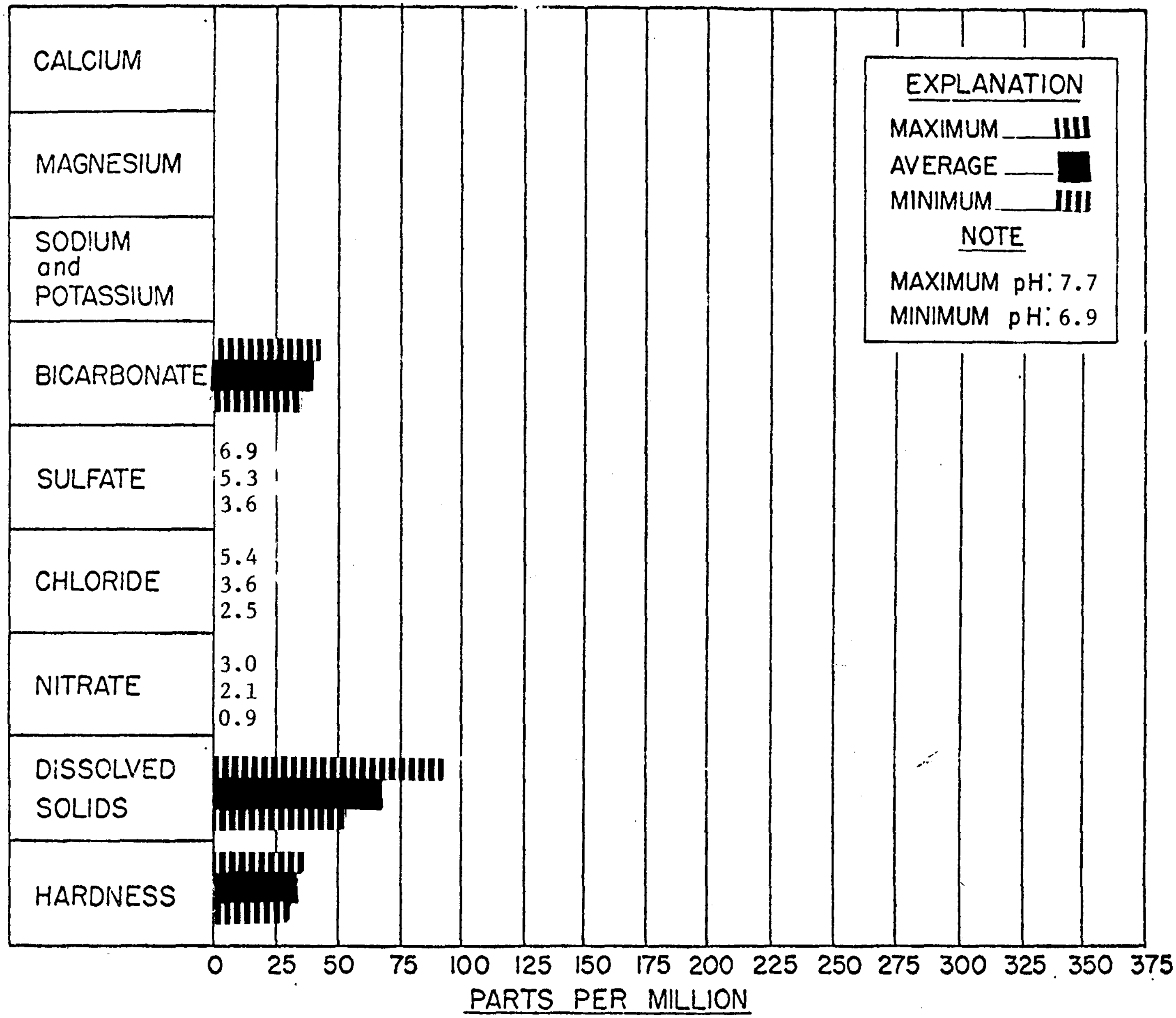
A. Description of Sampling Stations

Samples of the water, for testing its quality, were taken at a U.S.G.S. flow gageing station on Mayfield Creek at Lovelaceville, Kentucky. This is located in Carlisle County, in the north central portion of the basin. Drainage area above the station is 212 sq. mi. representing 17 per cent of the total drainage area in the basin. Data obtained from this sampling point is shown in Table A-4 and presented graphically in Figure A-1.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts.

Thence the portion of the Mississippi River Basin in Kentucky, is very soft with a slight bicarbonate hardness. The following information was taken from "Water in the Economy of the Jackson Purchase Region", a Kentucky Geological Survey report. This basin is relatively undisturbed by man's activities which would cause a modification of the General Chemical Water Quality. The water of the region is therefore practically free from the influence of human

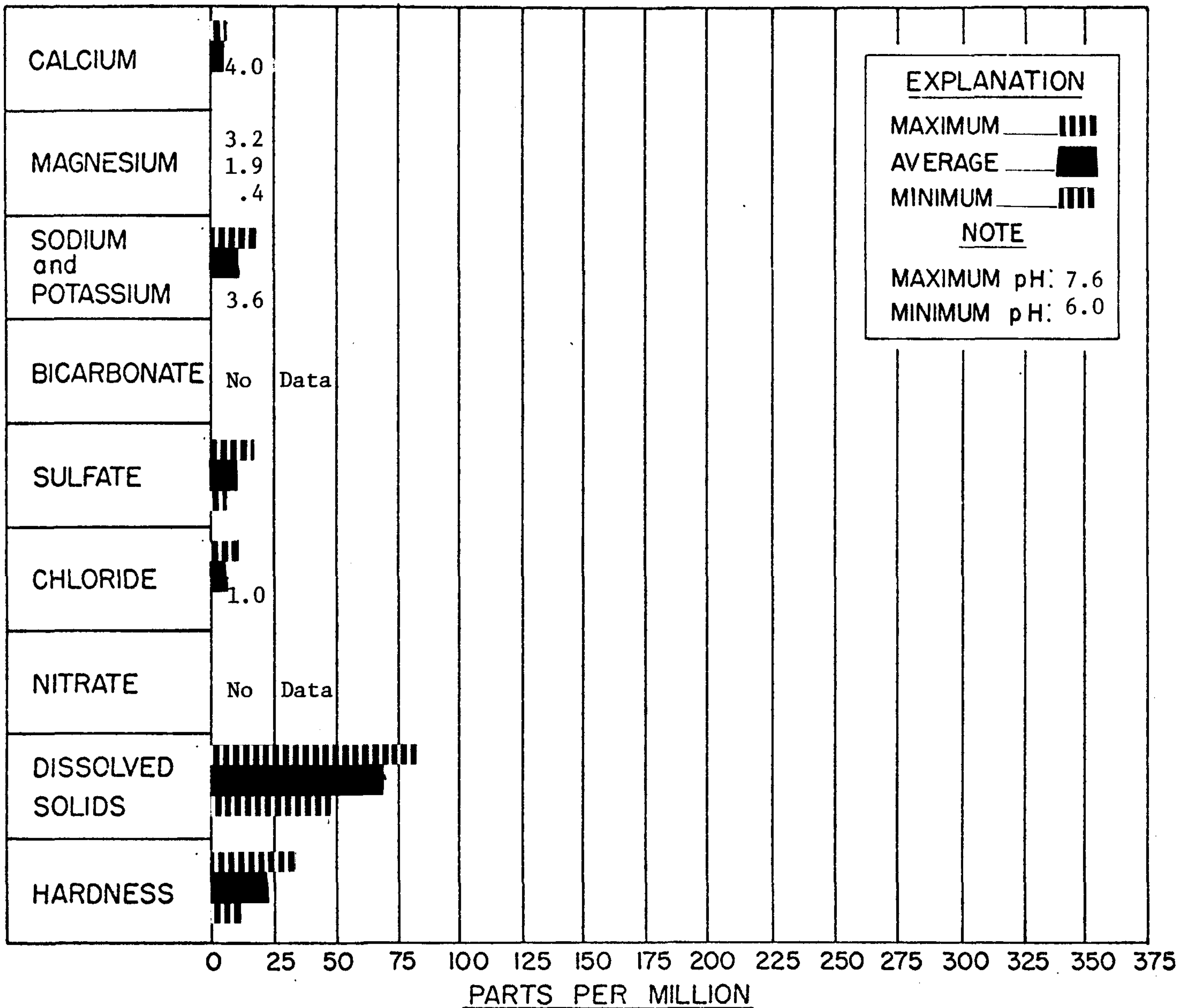


MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE A-1

Bayou de Chien

North Clinton



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE A-2

Mayfield Creek

Lovelaceville

10-60 to 8-72

related pollutants. For this reason, in all respects the quality of the surface water falls well within normal standards (excepting D.O. at extreme low flow periods) and is considered to be excellent as it is shown on Figure A-1.

C. Trace Chemical Water Quality

Trace elements under 5.0 mg/l are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

Trace chemicals in the surface water of the Mississippi River Basin in Kentucky were measured as being within Kentucky-Federal Water Quality Standards.

D. Waste Load Effects on Water Quality

Biochemical degradable waste impost a load on the dissolved oxygen recourses of a stream. Such waste loads are considered to have an effect upon water quality when they cause the dissolved oxygen (D.O.) concentration to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Based on a model developed for the Kentucky Continuing Planning Process for River Basin Management Planning, 275.0 miles of streams in the basin that receive waste discharges were evaluated. Based upon present treatment levels and once in 10 year 7 day low flows, there are 84.0 miles of stream where the D.O. concentration may be expected to fall below 5.0 mg/l. Thirteen of the 84 miles of stream are affected by a municipal discharge, 26 by industrial, and 45 by various other discharges. These distances represent 5 per cent, 11 per cent, and 15 per cent, respectively, of the total stream miles in the basin which were studied. (Table A-5)

E. Non-Point Source Effects

Non-point pollution is a problem in Kentucky's portion of the Mississippi River Basin. The major non-point sources of pollution in the basin are summarized below:

1. Land Use: Soil erosion from 273 square miles (22 per cent of basin area) of farm land is considered excessive. Logging operations, burning, and grazing in 56 square miles (.05 per cent of basin area) of forest land has resulted in severe soil erosion in the area.

2. Animal Wastes: All agricultural feedlots in Kentucky have a capacity of less than 1,000 animal units and, therefore, no NPDES Permits have been issued in Kentucky for feedlots. Kentucky has developed a manure lagoon disposal system in cooperation with the USDA-SCS which is currently under study and is used by some feedlots. These lagoon systems have been employed in the Mississippi River Basin and have minimized the waste load effect from feedlots when properly operated.

3. Urban Runoff: Mayfield, Kentucky is the only city which could influence water quality from urban runoff. The effect of urban runoff should be partially mitigated through a unique sanitary sewer overflow lagoon which acts as a detention and treatment basin before discharging to the main sewage treatment plant for further treatment. The overflow lagoon was a cost effective solution to a severe inflow/infiltration problem rather than eliminating stormwater access to the sanitary sewer system.

F. Water Uses

Surface and groundwaters in the Mississippi River Basin in Kentucky are used for public water supply, industry, fish and wildlife, recreation, and for agriculture. The groundwater of Kentucky's portion of the Mississippi River Basin is of good quality, however, iron removal is needed. The groundwater yield is high (500 g.p.m. and up to 1,700 g.p.m.) and is the source of all of the public water supply in the region. Public water usage is 2.0 million gallons per day (m.g.d.)

Industry, too, relies heavily upon the consistently high quality groundwater as its water source. Except for a large paper mill located directly on the Mississippi River (Westvaco) all of the industry in the basin uses 4 m.g.d. of groundwater for water supply.

There are no major organized recreational areas situated in the basin. However, the quality of the streams in the region is sufficiently high enough to support fish and wildlife, and to allow its recreational use.

Water in the basin is used in the agricultural industry primarily for livestock watering with a small amount used for irrigation.

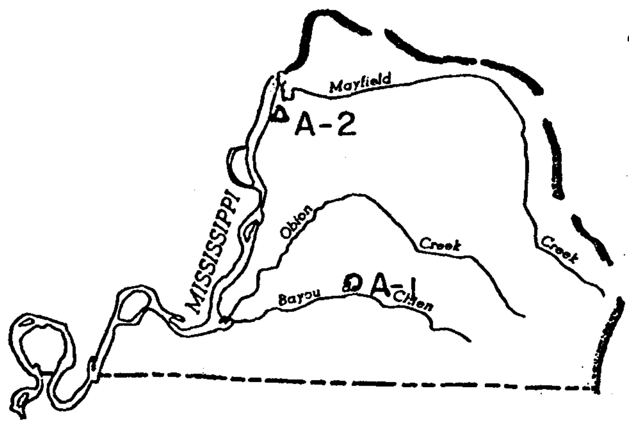
G. Water Quality Changes

The water quality through the basin is excellent and, therefore, sampling is limited and any change in water quality in the Mississippi River Basin in Kentucky must be observed over long periods to be meaningful.

III. Summary

The water quality in Kentucky's Mississippi River Basin is of high quality. There are some problems related to water quality that require attention. Soil erosion from both farm land and forest land presents a problem of sediment in the water.

Treated wastes discharged from municipal, independent, and industrial sources effect the quality of the basin's streams. The need to upgrade or eliminate waste sources is being determined in the basin planning process. Another aspect of this problem is the need for improved operation and maintenance of waste treatment facilities through a program of operator licensing and education. Kentucky has instituted such programs.



o U.S.G.S.

△ Kentucky Division of Water

MISSISSIPPI RIVER

10 0 10 20 30 40

GRAPHIC SCALE IN MILES

Base Data: U. S. Geological Survey

STATION KEY

A-1 BAYOU DE CHIEN NEAR CLINTON

A-2 MISSISSIPPI RIVER NEAR WICKLIFFE WPI

Table A-1
Population in the Mississippi River Basin by County

County	Area (sq. mi.)	1970 Pop.	Area in Basin (sq. mi.)	Pop. in Basin
Ballard	259	8,276	113	5,306
Calloway	384	27,692	17	610
Carlisle	195	5,354	195	5,354
Fulton	203	10,183	203	10,183
Graves	560	30,939	458	27,445
Hickman	246	6,264	246	6,264
McCracken	249	58,281	17	1,475
			1,249	56,637

Note: The information in this table was taken from the 1970 Census as reported in Rand McNally.

Table A-2

Water Withdrawal in the Mississippi River Basin

County-City-Withdrawer	River/Stream	SW	GW	Public (mgd)	Industrial (mgd)
Ballard					
Barlow Mncp. W. W.			x	.036	
LaCenter Mncp. W. W.			x	.1	
Wickliffe Mncp. W. W.			x	.08	
Westvaco	Miss. R.	x			25.0
Calloway	No Major Withdrawal				
Carlisle					
Arlington Mncp. W. W.			x	.02	
Deena of Arlington, Inc.			x	.001	.056
Bardwell City Utilities			x	.11	.012
Fulton					
Hickman Mncp. W. W.			x	.7	
Graves					
Cuba Mncp. W. W.			x	.006	
Fancy Farm Water Dist.			x	.041	
Hickory Water Dist.			x	.075	
Lynch Water Dist.			x	.003	
Lowes - Mrs. John Lowe			x	.005	
Lynnville - Motheral Water Co.			x	.007	
Mayfield Mncp. W. W.			x	.66	.49
Beadleton Comm. W. System			x	.005	
Hardeman Water Dist.			x	.018	
Dairy Brand of Mayfield, Ky.			x		.012
General Tire and Rubber Co.			x		3.2
Pet Milk Co.			x		.25
Sedalia Water Dist.			x	.014	
Tri-City - Mrs. Myrtle Casey			x	.004	
Water Valley Mncp. W. W.			x	.075	
Wingo Mncp. W. W.			x	.092	.005
Hickman					
Clinton-Ky. W. Service Co.			x	.11	.013
Columbus Mncp. W. W.			x	.011	
McCracken	No Major Withdrawal				

*Mncp. W. W. - Municipal Water Works

NOTE: Data obtained from Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources.

Table A - 3

City Population and Facility Grant Status
in the Mississippi River Basin in Kentucky

County	City	Population	Project Type	Comments
Ballard	Wickliffe	1,211	I	Underway
	Lacenter-	1,044	I	Pending
	Barlow	746		
	Kevil	274		
Calloway				
Carlisle	Bardwell-	1,049	I	Pending
	Arlington	549		
Fulton	Hickman	3,049	I	Underway
Graves	Mayfield	10,600	I	Underway
	Wingo	593	I	Pending
	Fancy Farm	550	I	Underway
Hickman	Clinton	1,618	None	Sewered
	Columbus	371	None	
McCracken				

No Major Population Center in the Basin.

*These are all of the cities with a population greater than 300.

NOTE: Data obtained from Kentucky Department for Natural Resources and Environmental Protection, Division of Water Quality.

Table A-4

Water Quality Data for the Mississippi River Basin

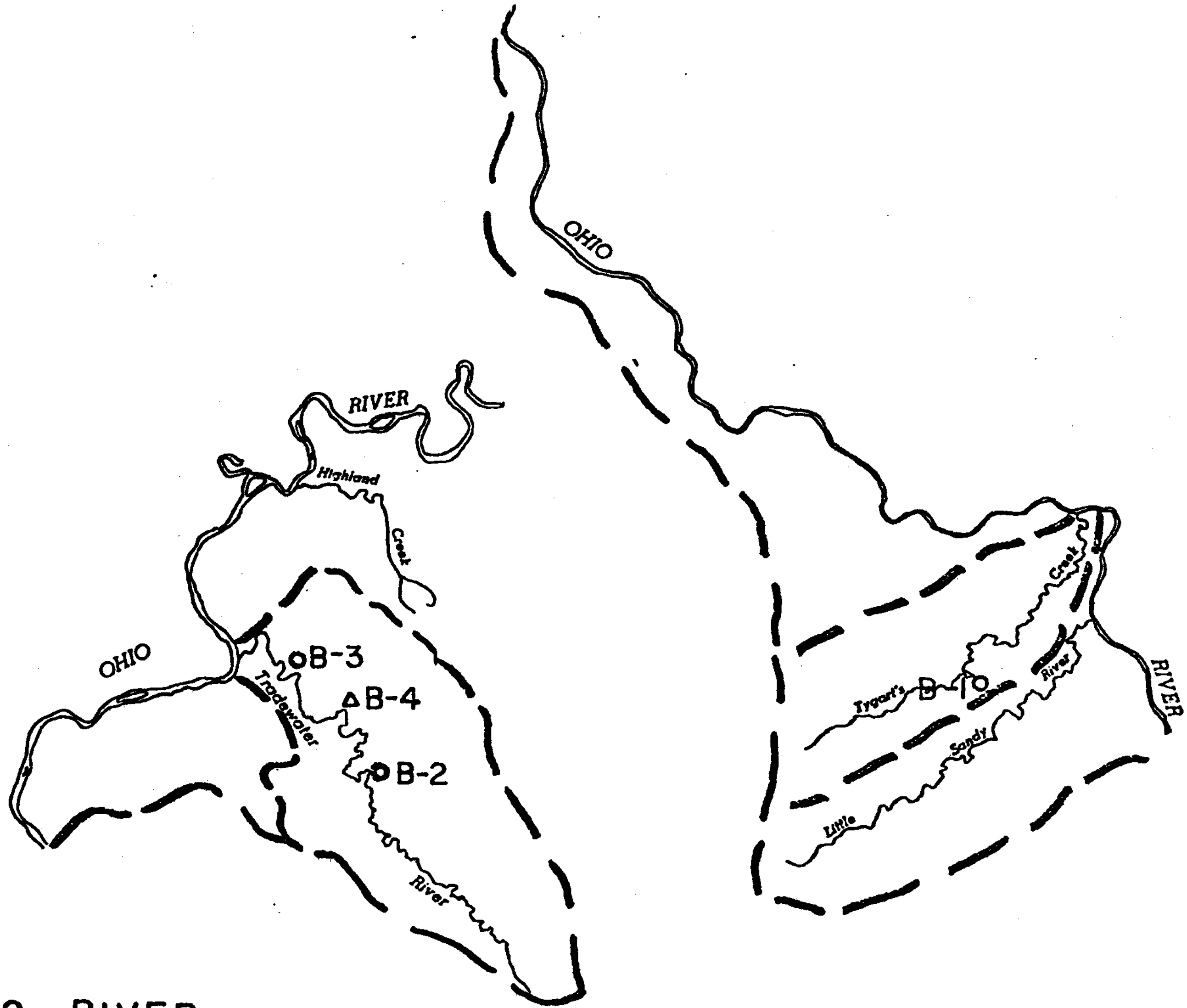
Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00400	pH Specific Units Kentucky Standard 6-LT pH LT 9						
Bayou De Chien, Clinton USGS #07024000	70/11/04	72/08/17	7.2	7.7	6.9	3	0.436
STORET #00095	Conductivity Micro mho, Ky. Std. 800 micro mhos						
Bayou De Chien, Clinton	70/11/04	72/08/17	105	122	95	3	14.6
STORET #70300	Residue mg/l (milligrams per liter), Ky. Std. 500 mg/l						
Bayou De Chien, Clinton	70/11/04	72/08/17	68	88	52	3	18.4
STORET #00900	Hardness mg/l, 0-60 Soft, 61-120 MOD, Hard, 121-180 Hard, 180 + Very Hard						
Bayou De Chien, Clinton	70/11/04	72/08/17	37	39	34	3	2.65
STORET #00940	Chloride mg/l, Proposed E.P.A. Std. 250 mg/l						
Bayou De Chien, Clinton	70/11/04	72/08/17	3.6	5.4	2.5	3	1.55
STORET #00945	Sulfate mg/l, Proposed E.P.A. Std. 250 mg/l						
Bayou De Chien, Clinton	70/11/04	72/08/17	5.3	6.9	3.6	3	1.65
STORET #00950	Fluoride mg/l, Ky. Std. 1.0 mg/l						
Bayou De Chien, Clinton	70/11/04	72/08/17	0.07	0.1	0.0	3	.0577
STORET #00410	Alkalinity mg/l, No Standard						
Bayou De Chien, Clinton	70/11/04	72/08/17	42	43	41	3	1.0
STORET #71851	Nitrate mg/l, Prop. E.P.A. Std. 10 mg/l						
Bayou De Chien, Clinton	70/11/04	72/08/17	2.1	3.0	0.9	3	1.07
STORET #31503	Total Coliform Count Per 100 ml., Ky. Std. 1000 per 100 ml.						
Mississippi R., Wickliffe WPI	75/01/07	75/12/16	1254	4700	25	11	
	74/04/16	75/12/16	1435	4700	25	21	
STORET #31616	Fecal Coliform Count Per 100 ml.						
Mississippi R., Wickliffe WPI	75/07/22	75/11/25	409	587	250	3	

Table A-5

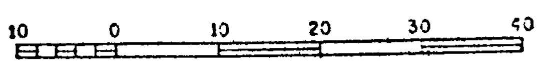
Organic Loads Affecting Streams in the Mississippi River Basin

Length of streams to which treated organic loads are discharged		275.0
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		84.0
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	13.0
	Industrial Discharges	26
	Other Discharges	45

Note: This information is from the wasteload allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q10-7) low flow.



OHIO RIVER



GRAPHIC SCALE IN MILES

Base Data: U. S. Geological Survey

OHIO RIVER BASIN - MINOR TRIBUTARIES

The minor tributaries to the Ohio River which are to be considered are the Tradewater River, the Little Sandy River and Tygarts Creek along with other small drainage basins which have drainage directly to the Ohio River rather than major tributaries. The main stem of the Ohio River of the Water Quality Report has been prepared for the 8 signator states composing the Ohio River Valley Sanitation Commission and this separate report is available on request from ORSANCO, 414 Walnut Street, Cincinnati, Ohio.

I. Basin Description

A. Geography

Since the border of the Ohio River forms the north border of the Commonwealth of Kentucky and is 610 miles in extent; the geography will be discussed in three separate sections. (1) The area from Ashland to Northern Kentucky, (2) the area from Northern Kentucky to Louisville, and (3) Louisville to the mouth of the Ohio.

In the first area (1) there are three tributaries in the sub-basin; two of which, the Little Sandy and Tygarts Creek, compose about two thirds of the drainage basin area from Ashland to Northern Kentucky. This portion of the drainage basin is relatively uninhabited with the exception of three towns over 1,000 population. It is very hilly and activity from crop forming is restricted by the topography.

The second area (2) running from Northern Kentucky to Louisville has one drainage basin with an area of over 100 square miles that is Harrods Creek. The geography of the area is very similar to the first area.

The third area (3) from Louisville to the mouth contains one large drainage basin,the Tradewater River. The Tradewater River has a drainage area of 940 square miles. Two other tributaries - Highland Creek and Sinking Creek - have drainage areas of over 100 square miles. Generally, this area has some farm and mining activities; the intense mining activities are in the Tradwater River Basin.

B. Topography

The particular topographic feature which relates to water quality is the slope of the streams. The slope of a stream directly relates to the ability or capacity of the stream for waste load assimilation. The slope relates to the reaeration capability and if the stream has no flow, a direct relationship of the slope to the waste load exists permitting a simple estimate of load which can be discharged into that stream. In area one (1), the slopes of the streams are: Little Sandy River, 8.3 feet per mile and Tygarts Creek, 6.9 feet per mile. In area two (2), the stream slopes are somewhat flatter, varying from three to four feet per mile. In area three (3), the Tradewater River has an average slope of 1.3 feet per mile from the headwater to mile point 70 from the Ohio River. The lower portion from mile point 60 to the mouth is subject to backwater influences of the Ohio River. The lower 70 miles has a slope of 0.7 feet per mile. In area three (3), the slope is generally less than 3 feet per mile for the minor tributaries.

C. Geology

An important geological feature of the Ohio River minor tributaries is a glacial alluvial deposit that extends from a half mile to 5 or 6 miles and forms an important source of groundwater. This groundwater area is particularly important in Louisville where the withdrawal rate exceeds 50 MGD and for Owensboro, groundwater is the source of the public water supply. An unique feature of the Louisville area is the ability to use seepage pits for waste disposal from private residences. This and one other area in the United States were known to be sites for such practice. The reason for this is a hard pan layer of clay which prevents the interchange of seepage pit waste into the groundwater aquifer. Another important geological feature is the occurence of large coal reserves and to some extent petroleum resources, with extensive mining in Hopkins County. The coal reserves are shallow and strip mining can be practical for many of the coal seams present.

D. Hydrology

Tygarts Creek and the Tradewater have no locks or dams.

The Little Sandy River has an impoundment near Grayson Kentucky. The resultant lake, Grayson Reservoir, is used for flood control, recreation, fish and wildlife, and low flow augmentation. The lake has a volume of 10,600 acre feet and an area of 1,500 acres.

E. Population

The population of the basin in Kentucky was 993,011 in the year 1970 according to the U.S. Census. The largest city in this area is Louisville with a population of 358,000. Other population centers are Ashland, Northern Kentucky principally the cities of Covington, Newport, Owensboro, Henderson and Paducah. All of these cities discharge into the Ohio River and not into their minor tributary basins. The population in the minor tributaries is predominately urban because of the Ohio River cities. Kentucky has 5 SMSAs and 4 of them are along the Ohio River with the exception of Lexington. As the result of the population concentration and water pollution problems in the Ohio itself, three of these complexes (Louisville, Northern Kentucky and Ashland-Huntington) are being studied under an Areawide Wastewater Management Planning (Section 208 of Public Law 92-500) as well as Urban Studies of the Corps of Engineers.

TABLE B-3

SURFACE WATER RECORDS FOR THE OHIO RIVER BASIN-MINOR TRIBUTARIES

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Little Sandy River Below Grayson Dam near Leon**	9 yr.	196 sq.mi.	261 cfs, 1.3 cfs*/sq.mi.	5,600 cfs, 29 cfs/sq.mi.	0 cfs.	0 cfs.
	wtr/yr 1975		364 cfs, 1.9 cfs/sq.mi.	2,690 cfs, 14 cfs/sq.mi.	18 cfs, 0.1 cfs/sq.mi.	
Tygarts Creek near Greenup	35 yr.	242 sq.mi.	305 cfs, 1.3 cfs/sq.mi.	14,800 cfs, 61 cfs/sq.mi.	0 cfs.	0 cfs.
	wtr/yr 1975		474 cfs, 2.0 cfs/sq.mi.	7,400 cfs, 31 cfs/sq.mi.	6.4 cfs, 0.0 cfs/sq.mi.	
Tradewater River at Olney	35 yr.	255 sq.mi.	329 cfs, 1.3 cfs/sq.mi.	13,600 cfs, 53 cfs/sq.mi.	0 cfs.	0 cfs.
	wtr/yr 1975		521 cfs, 2.0 cfs/sq.mi.	4,860 cfs, 19 cfs/sq.mi.	1.4 cfs, 0.0 cfs/sq.mi.	

* Cubic feet per second

** Flow regulated since July 1, 1968 by Grayson Lake.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

A. Description of Water Sampling Stations

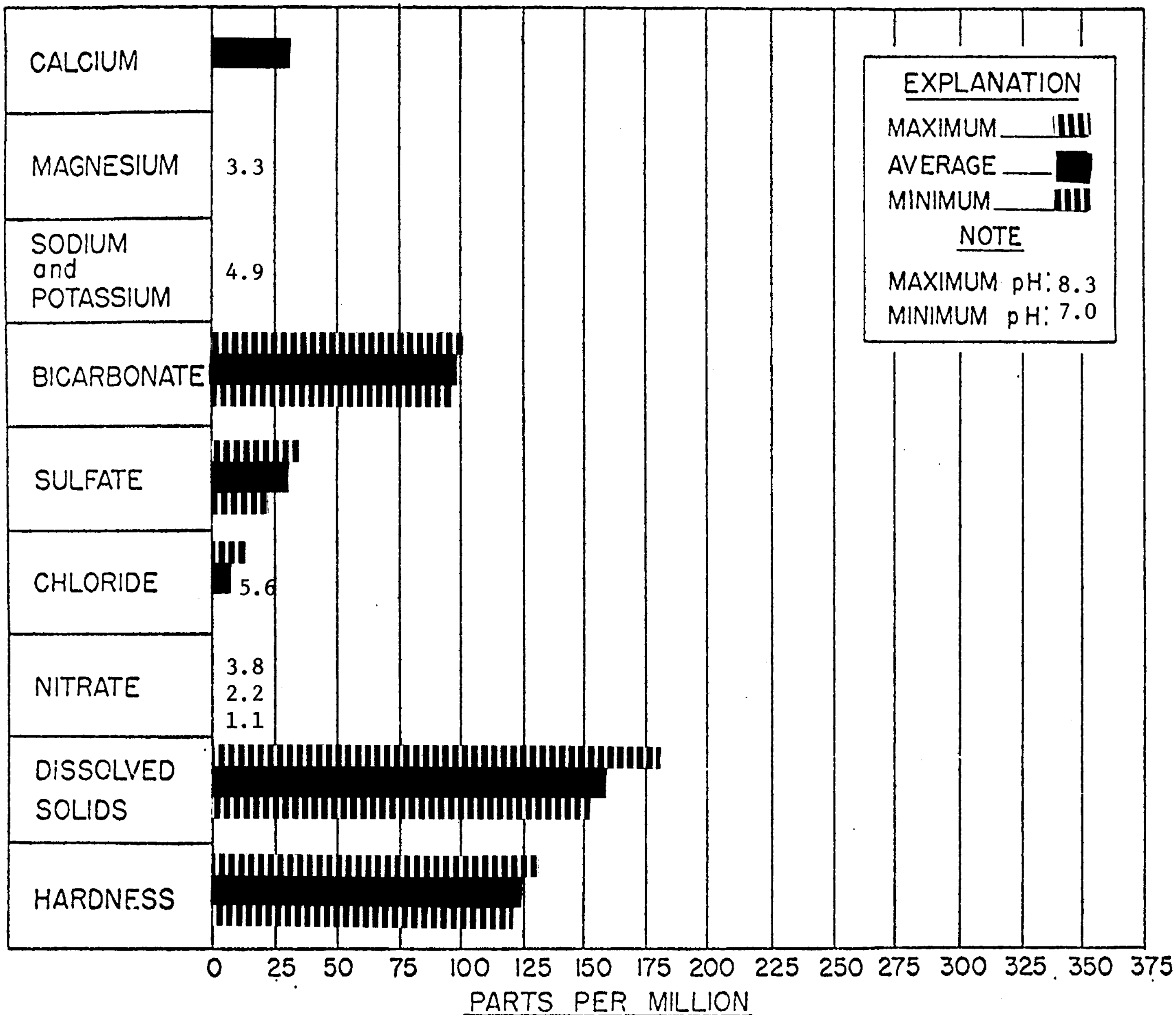
Examination of the character of the water in the minor tributaries was made by selecting two sampling stations. One on Tygarts Creek near Greenup Kentucky was selected since it most closely relates to the water quality through the basin. The other station was selected on the Tradewater River since it reflects the condition of a river which is subjected to acid mine drainage.

B. General Chemical Water Quality - Tygarts Creek and Tradewater River

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The type of rock formation which the surface waters contact cause the predominate chemical characteristics when measured over a year period. The contribution of groundwater, which is generally higher in dissolved solids, than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky are ones which have moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicated when the sulfate content increases higher than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20 -25 parts per million as an average value.

The water quality in Tygarts Creek near Greenup shown in Figure B-1 is typical of the water quality throughout the minor tributaries with the exception



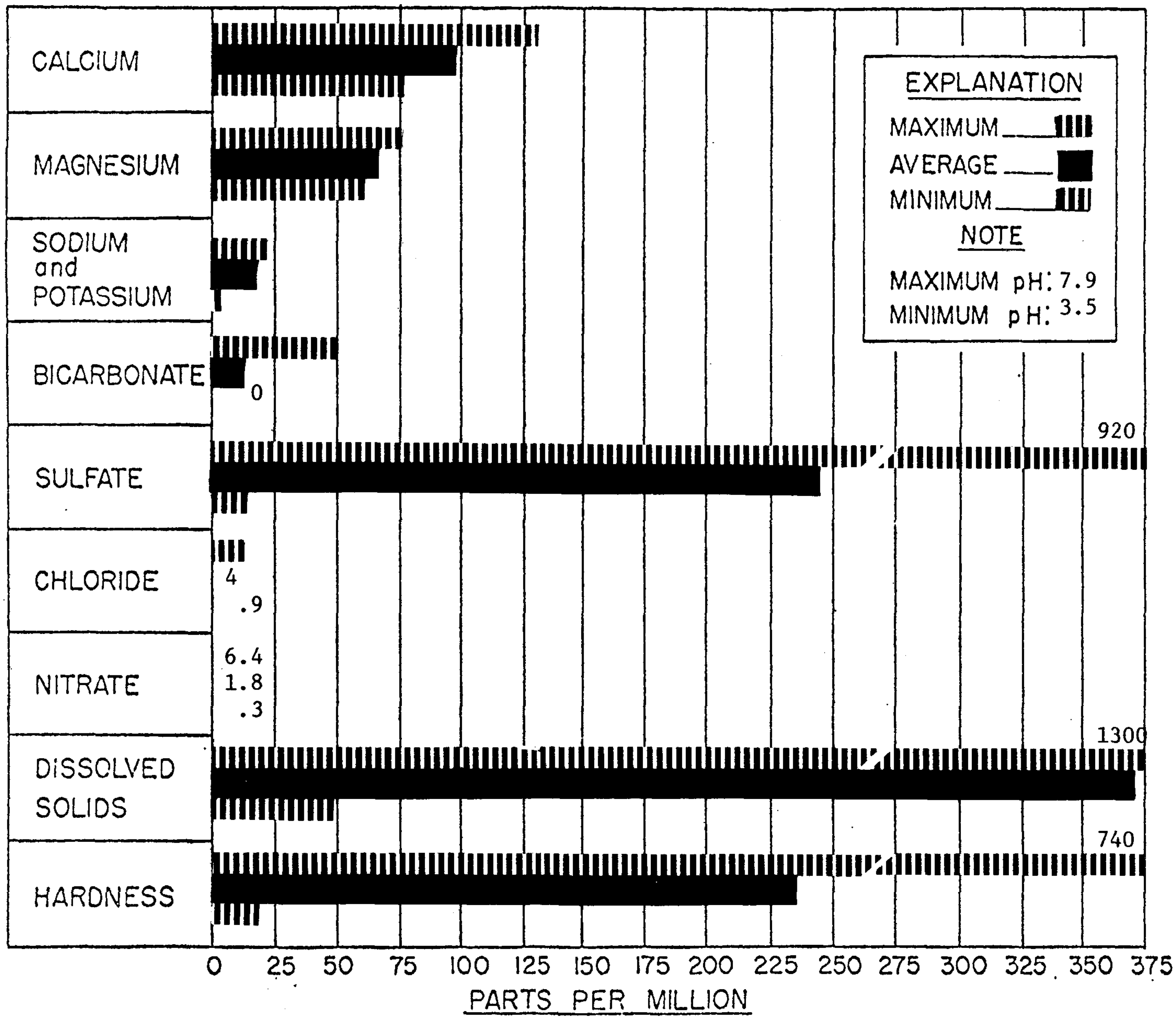
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE B-1

Tygarts Creek

Greenup

9-70 to 8-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE B-2

Tradewater River

Olney

3-70 to 9-73

of waters which are affected by acid mine drainage. The water in Tygarts Creek is of the calcium bicarbonate type, reasonably stable as viewed from the average to the maximum change in water quality, and slightly on the alkaline side with a pH in excess of a neutral 7. This water is hard, but softening for domestic purposes can be done through the lime softening process.

The Tradewater River was selected to show the effects of acid mine drainage on a watershed. Figure B-2 clearly illustrates this effect. The sulfate content is excessive with an average value of 240. The total dissolved solids content is near the water quality standard and the water is extremely hard. Further, this water exhibits very poor stability in that on occasions dissolved solids are five times the average and the pH shows a wide variation from 3.5 to 7.9. This water has very little buffering capacity as shown by the bicarbonate content which has been depleted by acid mine drainage effects.

C. Trace Chemical Water Quality

Trace elements are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

Trace Chemicals measured in the two basins are within Kentucky-Federal Water Quality Standards.

D. Waste Load Effect on Water Quality
(Tradewater and Little Sandy Rivers and Tygarts Creek)

Waste loads are considered to have an effect on water quality when they cause the dissolved oxygen concentration (D.O.) of the water to drop below the Kentucky Water Quality Standard of 5.0 milligrams per liter (mg/l).

Approximately 430 miles of stream length were studied under a model developed in the Kentucky Continuing Planning Process for River Basin Management Planning, used to determine waste load allocation. Using this model it was determined that 85 miles of that length would have a D.O. concentration of less than 5.0 mg/l when the flow is equal or less than the 10 year 7 day low flow. Of the stream length affected, eight miles (9 per cent) are by industrial discharge and 36 miles (42 per cent) are affected by municipal discharge. The remaining 41 miles (48 per cent) are affected by discharge from places such as schools, trailer parks, and subdivisions, etc.

E. Non-Point Source Effects Ohio River Kentucky Portion

Major non-point source pollutants of the basin's streams are sediment, agricultural pesticides, solid waste, and animal waste.

Excessive sediment is a result of erosion on surface mined areas, agricultural lands, forest lands, roadbanks, streambanks, construction, and developing areas.

Major erosion sources are summarized as follows:

1. Approximately 452 square miles of the basin's cropland have average erosion rates in excess of acceptable limits.

2. Much erosion is from about 531 square miles of disturbed forest lands. This comprises about 63 per cent of the erosion from forest lands while including about 20 per cent of the total forest lands.

3. An estimated 125 square miles of land in the basin are affected by gully erosion.

4. An estimated 3 square miles per year are being disturbed for industrial and urban expansion.

F. Water Uses

Water use in the minor tributaries from either surface or groundwater is limited since only eight small cities use water from these minor tributaries. There are, also, limited water uses for industrial purposes.

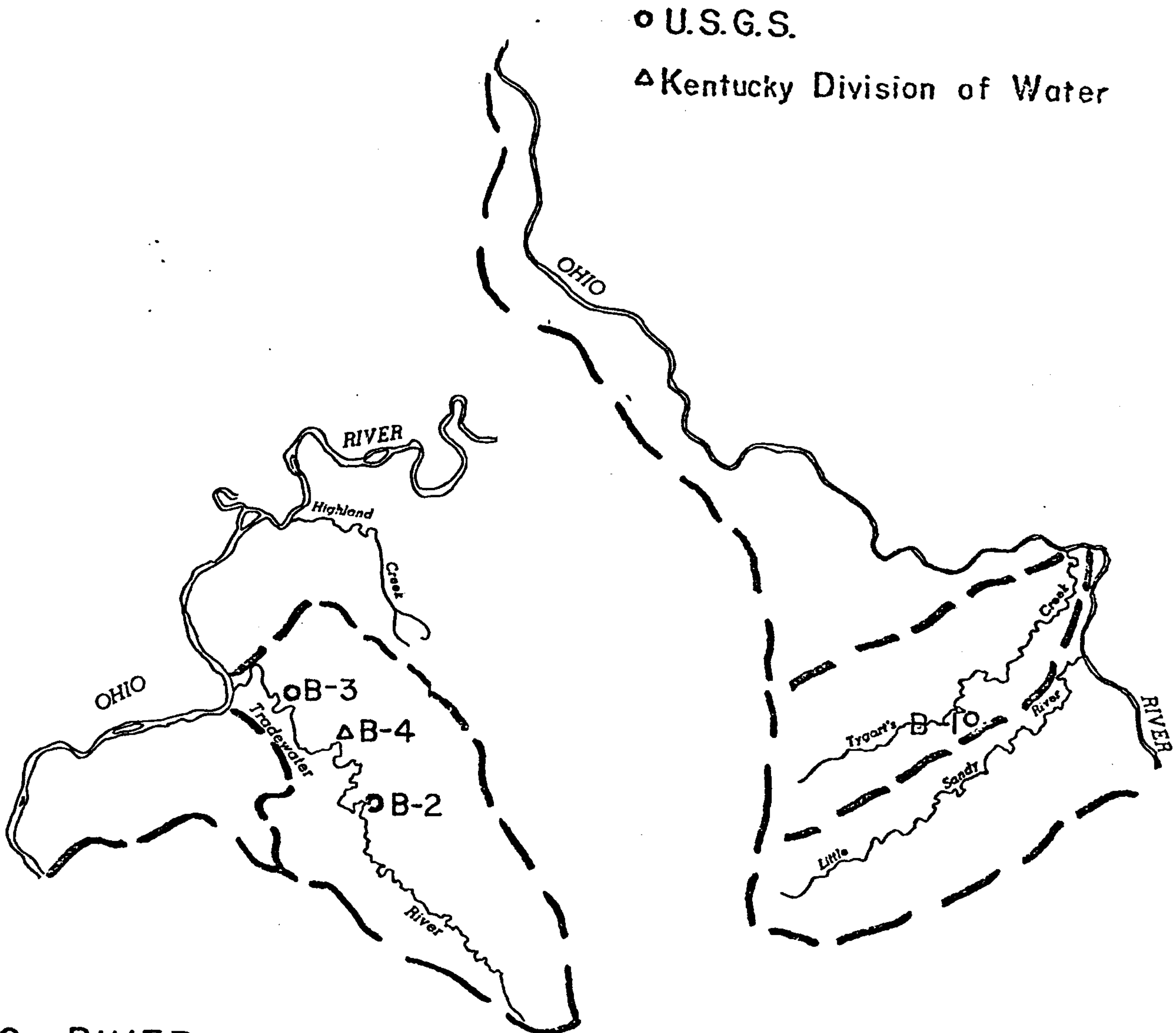
G. Water Quality Changes

The only area where water quality changes are expected in the minor tributaries of the Ohio River are in the Tradewater River Basin and the area of Union County where extensive coal resources exist. This change is anticipated due to the increased demand for coal. Some water quality change will result in the upgrading of waste treatment facilities.

III. Water Quality Causes and Corrections in the Tradewater and Little Sandy Rivers and Tygarts Creek

In the Little Sandy River and Tygarts Creek, the main problems are siltation and organic waste loads. Siltation is mainly from erosion and run-off due to improper agricultural and timbering practices. With the increase in interest for modern farming methods this problem should decrease. The organic waste loads, due to lack of proper treatment facilities, can be alleviated by upgrading treatment methods.

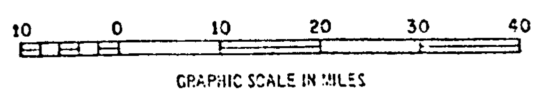
The main problem in the Tradewater River is acid mine drainage and siltation from the coal mining industry. This siltation is the result of two practices, strip mining which causes upheaval of the surface land, and logging which can result in high runoff rates and serious erosion. With the increase in demand for coal due to the energy crisis, great care and vigilance will need to be exercised to see that this problem does not increase.



OHIO RIVER

STATION KEY

B-1 TYGARTS CREEK NEAR GREENUP
B-2 TRADEWATER RIVER AT OLNEY
B-3 TRADEWATER RIVER AT SULLIVAN
B-4 TRADEWATER RIVER HIGHWAY 120



Base Data: U. S. Geological Survey

TABLE B-1

TOTAL DRAINATE AREA OF OHIO RIVER BASIN IN KENTUCKY
(Excluding the following rivers: Kentucky, Salt,
Green, Big Sandy, Licking, Cumberland and Tennessee

STREAM	DRAINAGE AREA (square miles)
Ohio River:	
Ohio River	6090
Tradewater River	940
Little Sandy River	720
Tygarts Creek	340
Kinniconik Creek	250

TABLE B-2

SLOPE CHARACTERISTICS OF THE LITTLE SANDY AND TRADEWATER RIVERS AND TYGARTS CREEK

STREAM	Average slope (ft./mi.)	Slope in lower 20 miles (ft./mi.)	Slope in lower 70 miles (ft./mi.)
Little Sandy River	8.3		1.7
A. East Fork	11.9	2.6	
B. Little Fork	15.2	3.5	
Tygarts Creek	6.9		3.3
Tradewater River	1.3		0.7

TABLE B-4

Population of the Ohio River Basin in Kentucky

County	Population in 1970 **	Population in basin *
Ballard	28,677	23,400
Boone	32,812	32,650
Boyd	52,376	43,600
Bracken	7,227	4,850
Breckinridge	14,789	10,200
Caldwell	13,179	3,600
Campbell	88,561	79,000
Carroll	8,523	1,600
Carter	19,850	19,850
Christian	56,224	5,400
Crittenden	8,493	7,300
Daviess	79,486	55,500
Elliott	5,933	5,700
Gallatin	4,134	4,134
Greenup	33,192	33,192
Hancock	7,080	6,400
Hardin	78,421	32,600
Henderson	36,031	32,600
Henry	10,910	3,350
Hopkins	38,167	10,200
Jefferson	695,055	371,700
Kenton	129,440	80,500
Lawrence	10,726	760
Lewis	12,355	11,450
Livingston	7,596	2,970
Mason	17,273	10,300
McCracken	58,281	41,800
Meade	18,796	18,696
Oldham	14,687	8,900
Pendleton	9,949	600
Rowan	17,010	1,000
Trimble	5,349	3,500
Union	15,882	15,882
Webster	13,282	9,700
	Total	992,990*

* Approximate measurement ± 10 per cent based on U.S. Census Data

** U. S. Census Data

Table B - 5

City Population and Facility Grant Status in the Ohio River Basin in Kentucky

County	City	Population	Project Type	Comments
Ballard				
Boone	Petersburg	430	None	No Sewers
Boyd	Ashland	29,200	I	Underway
			II & III	Pending
Bracken	Augusta	1,434	I	Underway
	Germantown	332	None	No Sewers
Breckinridge	Cloverport	1,388	None	Sewered
	Hardinsburg	1,547	I	Underway
	Irvington	1,300	I	Underway
Caldwell				
Campbell				
Carroll	Ghent	381	None	No Sewers
Carter	Grayson	2,184	I	Underway
	Olive Hill	1,197	I	Pending
Christian	Marion		None	Sewered
Crittenden				
Daviess	Owensboro	51,400	I	Underway
Elliott				

Table B - 5
Continued

County	City	Population	Project Type	Comments
Gallatin	Warsaw	1,232	I	Pending
Greenup	Bellefonte		None	Sewered
Hancock	Hawesville	1,262	I	Underway
	Lewisport	1,595	I	Underway
Hardin	Vine Grove-	2,987	I	Underway
	Radcliffe	7,881		
Henderson	Henderson-	23,100	I	Underway
	Corydon	880		
Henry	Campbellsburg	479	I	Pending
Hopkins	Dawson Springs	3,009	I	Underway
	Hanson	37	None	No Sewers
	Mortons Gap	1,169	None	No Sewers
	St. Charles	373	None	No Sewers
Jefferson	Anchorage	1,777	I	Complete
	Barbourmeade	884	I	Complete
	Bellemeade	576	I	Complete
	Brownsboro Farm	823	I	Complete
	Devondale	1,071	I	Complete
	Graymoor	1,419	I	Complete
	Indian Hills	600	I	Complete
	Keeneland	587	I	Complete
	Lake Louisvilla	430	I	Complete
	Louisville	358,000	II	Underway
			III	Pending
	Moorland	705	I	Complete
	Windy Hills	1,692	I	Complete

Table B - 5
Continued

County	City	Population	Project Type	Comments
Kenton	Lakeview		None	No Sewers
	Taylor Mill	3,194	None	No Sewers
Lawrence				
Lewis				
Livingston				
Mason	Maysville-	7,200	I	Underway
	Washington	439		
McCracken	Paducah	31,200	I	Underway
Meade	Brandenburg	1,637	III	Pending
Oldham	Oldham Co			
	W. D.		I	Pending
	I	Underway		
Pendleton				
Rowan				
Trimble	Bedford	780	I	Underway
	Milton	756	I	Underway
Union	Morganfield	3,563	I	Underway
	Sturgis	2,210	I	Underway
	Uniontown	1,255	I	Sewered

Table B - 5
Continued

County	City	Population	Project Type	Comments
Webster	Clay	1,426	None	Sewered
	Dixon	572	None	No Sewers

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U. S. Census and the FY 75 construction grants list for Kentucky.

Table B-6

Water Quality Data for Ohio River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STOREET #00400	pH Specific Units, Ky. std. 6 LT pH LT 9						
Tygarts Cr., Greenup	70/09/10	72/09/06	7.5	8.3	7.0	3	.681
USGS #03217000	65/05/22	72/09/06	7.5	8.3	7.0	4	.560
	60/04/28	72/09/06	7.4	8.3	7.0	6	.485
Tradewater R., Olney	70/03/05	73/09/30	6.3	7.9	3.5	86	1.067
USGS #03383000	69/10/01	70/02/16	5.9	7.5	4.5	10	1.264
	69/03/26	69/09/02	5.6	7.2	3.9	12	1.276
	68/05/15	69/02/22	5.8	7.9	3.8	19	1.489
	68/03/22	68/04/28	6.9	7.3	6.2	3	0.608
STORET #00095	Conductivity Micro mhos, Ky. Std. 800 micro mhos						
Tygarts Cr., Greenup	75/02/16	75/06/24	190	250	120	3	65.6
	70/09/10	74/08/11	233	300	147	7	55.0
	65/05/22	74/08/11	232	300	147	8	51
	60/04/28	74/ 6/ -	210	300	100	9	61
Tradewater R., Olney	70/03/05	73/09/30	500	1570	50	86	333.3
	69/10/01	70/02/16	475	899	109	10	301.5
	69/03/26	69/09/02	579	1610	60	12	467.1
	68/05/15	69/02/22	662	1440	109	19	431.2
	68/03/22	68/04/28	259	507	114	3	215.8
Tradewater R., Sullivan	75/08/27	75/11/12	810	1200	420	2	551.5
USGS #03384180							
STORET #70300	Residue mg/l (milligrams per liter), Ky. Std. 500 mg/l						
Tygarts Cr., Greenup	70/09/10	72/09/06	166	180	152	3	14.0
	60/04/28	72/09/06	136	180	71	5	44.7
Tradewater R., Olney	70/03/05	73/09/30	373	1300	48	86	287.6
	69/10/01	70/02/16	353	695	74	10	242.4
	69/03/26	69/09/02	445	1410	56	12	412.6
	68/05/15	69/02/22	518	1260	90	19	380.0
	68/03/22	68/04/28	186	362	88	3	152.7
STORET #00410	Alkalinity mg/l, No standard						
Tygarts Cr., Greenup	70/09/10	72/09/06	99	101	97	3	2.1
	60/04/28	72/09/06	81	101	35	5	28.0

Table B-6
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Tradewater R., Olney	70/03/05	73/09/30	13	49	0	86	10.2
	69/10/01	70/02/16	6	16	0	10	6.6
	69/03/26	69/09/02	6.7	20	0	12	7.2
	68/05/15	69/02/22	7.5	23	0	19	7.0
	68/03/22	68/04/28	13	16	7	3	5.2
STORET #00900	Hardness mg/l, 0-60 Soft, 61-120 Mod. Hard, 121-180 Hard, 180+ Very Hard						
Tygarts Cr., Greenup	70/09/10	72/09/06	125	130	120	3	5.0
	65/05/22	72/09/06	119	130	102	4	12.1
	60/04/28	72/09/06	102	130	47	6	31.0
Tradewater R., Olney	70/03/05	73/09/30	235	740	15	86	165.5
	69/10/01	70/02/16	222	447	42	10	157.1
	69/03/26	69/09/02	278	772	25	12	240.9
	68/05/15	69/02/22	305	729	43	19	213.8
	68/03/22	68/04/28	115	238	44	3	107.2
STORET #00080	Color Platinum Cobalt Units, Prop. EPA Std.75 Units						
Tygarts Cr., Greenup	65/05/22	65/05/22	3			1	
	60/04/28	65/05/22	20	50	3	3	26.1
Tradewater R., Olney	71/11/25	72/10/30	10	15	5	3	5.0
	69/11/12	69/11/21	17.5	30	5	2	17.7
	68/11/23	68/11/23	5			1	
STORET #00930	Sodium mg/l, No Standard						
Tygarts Cr., Greenup	60/04/28	60/04/28	3.8			1	
Tradewater R., Olney	70/11/04	72/11/05	13	14	12	4	0.82
	69/11/12	69/11/12	15			1	
	68/11/23	68/11/23	18			1	
STORET #00935	Potassium mg/l, No Standard						
Tygarts Cr., Greenup	60/04/28	60/04/28	1.1			1	
Tradewater R., Olney	70/11/04	72/11/05	4.8	5.2	4.4	4	0.34
	69/11/12	69/11/12	3.4			1	
	68/11/23	68/11/23	5.1			1	

Table B-6
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00940	Chloride mg/l, Proposed EPA Std. 250 mg/l						
Tygarts Cr., Greenup	70/09/10	72/09/06	8.5	13.0	5.6	3	3.97
	65/05/22	72/09/06	7.3	13.0	4.0	4	3.94
	60/04/28	72/09/06	6.0	13.0	1.0	6	
Tradewater R., Olney	70/03/05	73/09/30	4.0	11.0	0.9	86	1.68
	69/10/01	70/02/16	6.6	10.0	3.0	10	2.62
	69/03/26	69/09/02	5.5	21.0	2.0	12	5.18
	68/05/15	69/02/22	5.1	10.0	1.0	19	2.45
	68/03/22	68/04/28	3.5	5.0	2.5	3	1.32
STORET #00945	Sulfate mg/l, Proposed EPA Std. 250 mg/l						
Tygarts Cr., Greenup	70/09/10	72/09/06	27	31	23	3	4.04
	65/05/22	72/09/06	26	31	23	4	3.40
	60/04/28	72/09/06	24	31	14	6	5.56
Tradewater R., Olney	70/03/05	73/09/30	229	920	12	85	194.7
	69/10/01	70/02/16	223	480	31	10	166.2
	69/03/26	69/09/02	292	990	12	12	287.9
	68/05/15	69/02/22	339	860	29	19	266.3
	68/03/22	68/04/28	105	233	32	3	111.0
STORET #71851	Nitrate mg/l, Prop. EPA Std. 10 mg/l						
Tygarts Cr., Greenup	70/09/10	72/09/06	2.2	3.8	1.1	3	1.44
	65/05/22	72/09/06	1.7	3.8	0.2	4	1.53
	60/04/28	72/09/06	1.4	3.8	0.2	5	1.44
Tradewater R., Olney	70/03/05	73/09/30	1.8	6.4	0.3	86	0.91
	69/10/01	70/02/16	1.6	2.6	0.3	10	0.86
	69/03/26	69/09/02	1.4	2.8	0.5	12	0.82
	68/05/15	69/02/22	0.6	1.2	0.2	19	0.36
	68/03/22	68/04/28	1.3	2.0	0.7	3	0.67
STORET #00950	Fluoride mg/l, Ky. Std. 1.0 mg/l						
Tygarts Cr., Greenup	70/09/10	72/09/06	0.10	0.10	0.10	3	0.000
	60/04/28	72/09/06	0.12	0.20	0.10	4	0.050
Tradewater R., Olney	70/11/04	73/02/26	0.42	0.90	0.10	8	0.276
	69/11/12	69/11/17	0.50			1	
	68/11/23	68/11/23	1.20			1	

Table B-6
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00915	Calcium mg/l, No Standard						
Tygarts Cr., Greenup	60/04/28	60/04/28	30			1	
Tradewater R., Olney	70/11/04	72/11/05	95	130	76	4	25.5
	69/11/12	69/11/12	90			1	
	68/11/28		140			1	
STORET #00925	Magnesium mg/l, No Standard						
Tygarts Cr., Greenup	60/04/28	60/04/28	3.3			1	
Tradewater R., Olney	70/11/04	72/11/05	64	76	58	4	8.02
	69/11/12	69/11/12	54			1	
	68/11/23	68/11/23	92			1	
STORET #01025	Cadmium ug/l (Micrograms per liter), Ky. Std. 100 ug/l						
Tygarts Cr., Greenup	75/02/16	75/06/24	0.7	2.0	0.0	3	1.15
	74/04/10	74/09/20	1.2	3.0	0.0	5	1.10
Tradewater R., Sullivan	75/08/27	75/11/12	1.0	2.0	0.0	2	1.41
STORET #01056	Manganese ug/l, Prop. Ky. Std. 50 ug/l						
Tradewater R., Olney	70/03/05	73/09/30	2958	24000	0.0	84	4836
	69/10/01	70/02/16	4827	11000	0.0	10	4486
	69/03/26	69/09/02	4652	17000	0.0	12	5560
	68/05/15	69/02/22	5547	18000	0.0	19	5637
	68/03/22	68/04/28	1070	3200	0.0	3	1845
STORET #01046	Iron µg/l, Prop. EPA Std. 300 µg/l						
Tradewater R., Olney	70/03/05	73/09/30	49	730	0	84	92.9
	69/10/01	70/02/16	135	570	20	10	164.9
	69/03/26	69/09/02	177	1200	0	12	341.1
	68/05/15	69/02/22	89	480	10	19	112.1
	68/03/22	68/04/28	80	150	0	3	
STORET #01030	Chromium µg/l, Ky. Std. 50 ug/l						
Tygarts Cr., Greenup	75/02/16	75/06/24	0.3	1.0	0.0	3	0.577
	74/04/10	74/09/20	0.2	1.0	0.0	5	0.447

Table B-6
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Tradewater R., Sullivan	75/08/27	75/11/12	0.0	0.0	0.0	2	0.0
STORET #01049	Lead ug/l, Ky. Std. 50 ug/l						
Tygarts Cr., Greenup	75/02/16	75/06/24	5.7	7.0	5.0	3	1.155
	74/04/10	74/09/20	6.6	19.0	0.0	5	7.537
Tradewater R., Sullivan	75/08/27	75/11/12	3.0	6.0	0.0	2	4.243
STORET #01000	Arsenic ug/l, Ky. Std. 50 ug/l						
Tygarts Cr., Greenup	75/02/16	75/06/24	0.0	0.0	0.0	3	0.0
	74/04/10	74/09/20	1.2	5.0	0.0	5	2.168
Tradewater R., Sullivan	75/08/27	75/11/12	0.0	0.0	0.0	2	0.0
STORET #31503	Total Coliform Count Per 100 ml., Ky. Std. 1000 Per 100 ml.						
Tradewater R. Hwy. 120	75/01/07	75/12/15	1402	7400	15	12	
	74/07/23	75/12/15	1301	4700	15	13	
	74/04/30	74/09/04	820	2870	0	9	
STORET #31616	Fecal Coliform Count Per 100 ml.						
Tradewater R. Hwy. 120	75/12/15	75/12/15	3780			1	

TABLE B-8

Water Withdrawal - Ohio River Basin

	Source	SW*	GW**	(Million Gallons/Day) Public	Industrial
Boyd					
Ashland Mun. Water Works	Ohio River	x		3.442	1.475
Breckinridge					
Hardinsburg Mun. W. W.	Hardins Ck. Reservoir	x		.124	.001
Campbell					
Newport Municipal W. W.	Ohio River	x		5.065	.894
Carter					
Grayson Utility Comm.	Little Sandy	x		.282	
Olive Hill Mun. W. W.	Reservoir on Perry Branch	x		.166	.002
Carter Caves State Park	Tygarts Creek	x		.032	
Crittenden					
Marion Municipal W. W.	Reservoir	x		.264	.088
Greenup					
Greenbo Lake State Park	Greenbo Lake	x		.008	
Russell - C & O Railroad	Ohio River	x	x		.100 GW
	Wells (3)				.900 GW
Wurtland - E.I. Dupont DeNemours Co.	Ohio River	x	x		.034 GW
	Wells (2)				5.400 SW
Hardin					
Ft. Knox	Otter Creek	x	x	4.711 GW	.523 GW
	12 wells			2.385 SW	.265 SW
Vine Grove	Otter Creek & Brushy Fk.	x		.233	
Henderson					
Henderson Municipal W. W.	Ohio River	x		3.090	.421
Henderson Farmers Tankage	Ohio River	x			.421
Jefferson					
Louisville Water Co.	Ohio River	x		62.290	52.271
Airco Alloys & Carbide	Ohio River	x	x		2.100 GW
	& 6 wells				8.000 SW
E.I. Dupont DeNemours Co.	Ohio River	x	x		5.641 GW
	& 10 wells				68.515 SW

	Source	SW*	GW**	(Million Gallons/Day) Public	Industrial
Kenton					
Covington Municipal W. W.	Ohio River	x		5.800	1.800
McCracken					
Paducah Municipal W. W.	Ohio River	x		4.641	.819
Shawnee Steam Plant	Ohio River	x		.028	1.581
Mason					
Maysville Utility Comm.	Ohio River	x		.748	.499
Meade					
Otter Creek Park	Otter Creek	x		.047	
Oldham					
LaGrange Municipal W. W.	Brush Creek Reservoir	x		.479	.084
Union					
Morganfield Water Works	Ohio River	x		.650	
Hamilton Mine	Ohio River				.031
DeKovin Mine	Denis O'Nan Reservoir and well	x	x		.030 GW .170 SW
Uniontown Municipal W. W.	Ohio River	x		.102	.005
			Total SW	92.261	143.642
			Total GW	4.711	8.394

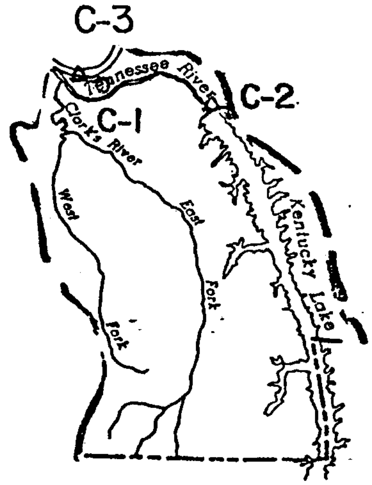
*Surface water
**Ground water

TABLE B-9

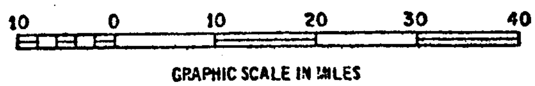
Organic Loads Affecting Streams in the Ohio River Basin

Length of streams to which treated organic loads are discharged	431 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow	85 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to Municipal Discharges	36 miles
Industrial Discharges	8 miles
Other Discharges	41 miles

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning effort. The values indicated the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year, seven day, low flow.



TENNESSEE RIVER



Base Data: U. S. Geological Survey

THE TENNESSEE RIVER BASIN

The Kentucky portion of the Tennessee River basin makes up the Eastern half of an area in the far western corner of the state called the Jackson Purchase region (named after General Andrew Jackson who, in 1818, arranged the purchase treaty with the Chickasaw Indians). The Jackson Purchase region is unique in many respects from the rest of Kentucky. This report will discuss first the Tennessee River basin in general in this region of Kentucky, and secondly discuss existing water quality in the area and the factors that influence water quality in the basin.

I. Basin Description

A. Geography

The Tennessee River joins the Ohio River near Paducah, Kentucky, at mile point 46.9 of the Ohio. The Tennessee River crosses the Kentucky-Tennessee border at mile point 51.1 and continues along the border to mile point 62.3, where it leaves Kentucky.

The basin encompasses all or portions of the following counties in Kentucky: Calloway, Graves, Livingston, Lyon, Marshall, McCracken, and Trigg. Of the total drainage area for the river of 40,330 sq. mi., approximately 1,000 sq. mi. are in Kentucky. (See Table I) The one major tributary to the Tennessee River in Kentucky is the Clarks River, which has a total drainage area of 530 sq. mi. The remaining area drains directly into the Tennessee River.

B. Topography

Low hills comprise the headwater areas which become rolling hills, then abruptly change to a flood plain as it nears the main stem. Elevations vary from

300 to 620 feet above sea level, with an average slope in the East Fork of Clark's River of 4.6 ft./mi., and 7.0 ft./mi. in the West Fork. The main stem of the Tennessee River to mile point 22 is within the influence of the Lock and Dam 52 on the Ohio with a pool elevation of 302. At mile point 22 Kentucky Dam forms Kentucky Lake and the pool extends into Tennessee to the Pickwick Landing Dam.

C. Geology

The geology of the area is made up of 4 major types of formations, all of which are primarily sand and clay mixtures, with gravel and silt in varying amounts. The bedrock of the area consists of limestone, chert, and dolomite.

The sand and clay formations are generally sources of good quality groundwater. Groundwater from the bedrock is often high in iron content, and can be treated if necessary before use. Generally, the groundwater quality is consistently good and may yield as much as 1,700 gallons per minute (g.p.m.). For these reasons it is a valuable source of domestic and industrial water supply in the basin.

D. Hydrology

The Tennessee River itself is a highly developed river system, with a series of locks and dams from near the mouth to the upper headwaters. Also, for navigation and for better flow regulation a canal was built between Lake Barkley and Kentucky Lake. The impoundment of the Tennessee River has resulted in superb regulation and increased the minimum daily flow from 5000 cfs to in excess of 20,000 cfs.

Flow in the Clarks River is not regulated or augmented by dams and reservoirs.

Flow measurements have been taken on the main stem of the Tennessee River and on both the East and West Forks of Clark's River. These recorded flows are depicted in table C-6 on the following page.

Periodically, flow on the main stem of the Tennessee River below Kentucky Dam goes to zero due to maintenance and operation of the turbines for hydroelectric power generation. These flow outages do not exceed 7 days, and impounding provisions for waste discharges are provided to accommodate this flow outage.

Kentucky Lake is the only lake of note in the Tennessee River basin in Kentucky. It is a multi-purpose reservoir, for flow augmentation, flood control, hydroelectric power production, and recreation. The lake's maximum capacity is 7,415,000 acre feet, covering an average area of 306,000 acres.

E. Population

The total population in the Tennessee River basin in Kentucky is 68,412. Murray, Kentucky, in Calloway County, with a population of 13,700 is the largest city in the area. Seven smaller communities make up the rest of the urban population which totals 25,277. This represents 37 per cent of the total population. The remainder of the population is located in rural areas. The urban distribution is shown in Table C-3.

Population in a basin is an important factor in the water quality of the basin, as water is used for a great variety of purposes, then discharges back into the streams. Influence of waste discharges are discussed in the second part of this report.

TABLE C-6

SURFACE WATER RECORDS FOR THE TENNESSEE RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Tennessee River near Paducah	76 yr.**	40,200 sq.mi.	64,060 cfs, 1.6cfs*/sq.mi.	500,000 cfs, 12 cfs/sq.mi.	60 cfs, 0.0cfs/sq.mi.	712.0 cfs
	10 yr.**		67,320 cfs, 1.7cfs/sq.mi.	420,000 cfs, 10 cfs/sq.mi.	23,900 cfs, 0.6cfs/sq.mi.	
	wtr/yr 1975		83,800 cfs, 2.1cfs/sq.mi.	400,000 cfs, 10 cfs/sq.mi.	24,100 cfs, 0.6cfs/sq.mi.	
East Fork Clarks River near Benton	wtr/yr 1975***	227 sq.mi.		33,400 cfs, 147cfs/sq.mi.		2.2 cfs
West Fork Clarks River near Brewers	7 yr.	68.7 sq.mi.	98.8 cfs, 1.4cfs/sq.mi.	9,370 cfs, 136cfs/sq.mi.	1.2 cfs, 0.0cfs/sq.mi.	0.8 cfs
	wtr/yr 1975		158 cfs, 2.3cfs/sq.mi.	5,980 cfs, 87 cfs/sq.mi.	3.2 cfs, 0.0cfs/sq.mi.	

* Cubic feet per second

** 76 Years (1889-1965), prior to opening of Barkley-Kentucky Canal.
10 Years (1965-1975), since opening of Barkley-Kentucky Canal.

*** Operated as a continuous-record gaging station 1938-73, and as a crest-stage partial-record station since 1974.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

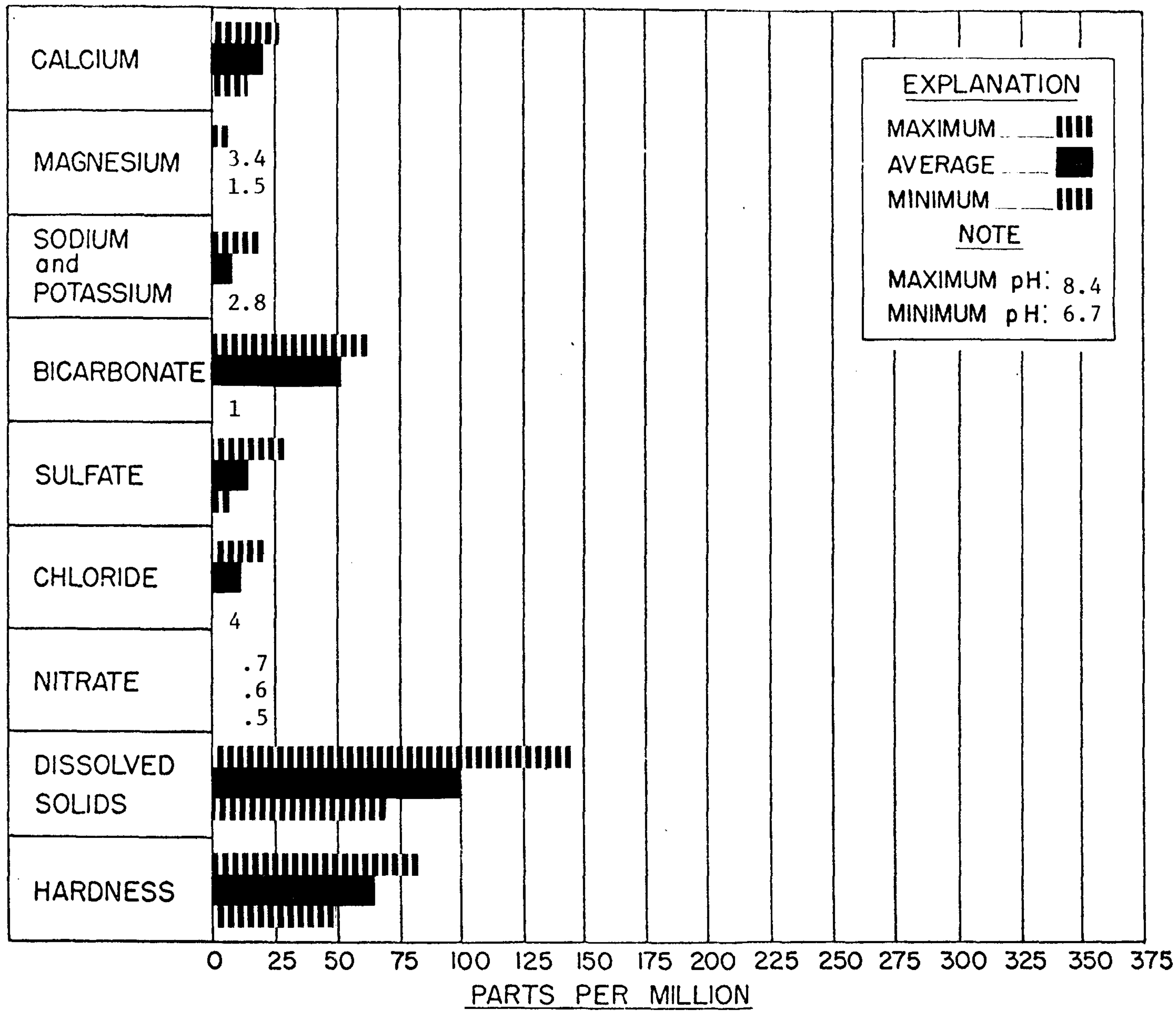
A. Description of Sampling Stations

Samples of the water, for testing its quality, were taken at a U.S.G.S. flow gauging station on the Tennessee River near Paducah, Kentucky. This is located in the far northern portion of the basin. Drainage area above the station is 40,200 sq. mi., representing almost the entire drainage area in the Tennessee River basin. Data obtained from this sampling and testing is listed in Table A-4 and Figure A-1.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts.

In the main stem of the Tennessee River in Kentucky, the quality of the water is excellent. The impoundment of the water by Kentucky Dam has shown a marked stabilization effect on water quality values (little variation between maximum and minimum). This consistency of water quality is significant in that when water quality is stable, standards for effluent discharged into that water may be well defined, and more confidence can be placed in monitoring results. The data was insufficient to reach a conclusion concerning the water quality of Clarks River.



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE C-1

Tennessee River

Paducah

10-59 to 11-74

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

Trace chemicals in the surface water of the main stem of the Tennessee River in Kentucky were measured as being within Kentucky/Federal Water Quality Standards.

D. Waste Load Effects on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such waste loads are considered to have an effect upon water quality when they cause the dissolved oxygen (D.O.) concentration to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Based on a model developed for the Kentucky Continuing Planning Process for River Basin Management Planning, 248.0 miles of streams in the basin that receive waste discharges were evaluated. Based upon present treatment levels and once in 10 year 7 day low flows, the model indicated that in 59.0 miles of stream the D.O. concentration is below 5.0 mg/l. Fifteen of the 59.0 miles of streams are affected by a municipal discharge, 14 by industrial, and 30 miles by various other discharges (subdivisions, mobile home parks, small businesses, etc.). These distances represent 6 per cent, 6 per cent, and 12 per cent, respectively, of the total stream miles in the basin which have a discharge. (Table A-5)

E. Non-point Source Effects

Non-point pollution is a problem in Kentucky's portion of the Tennessee River basin. The major non-point sources of pollution in the basin are summarized below:

1. Land Use: Soil erosion from 145.0 sq. mi. (15% of basin area) of farm land is considered excessive by VIDA-SCS. Logging operations, burning, and grazing in 44 sq. mi. (5% of basin area) of forest land has resulted in severe soil erosion in the area.

2. Animal Wastes: All agricultural feedlots in Kentucky have a capacity of less than 1,000 animal units and no NPDES permits have been issued in Kentucky for feedlots. Kentucky has developed a manure lagoon disposal system in cooperation with the USDA-SCS which is currently under study and is used by some small feedlots. These lagoon systems have been employed in the Mississippi River Basin and protected water quality when properly operated.

3. Urban Run-off: Surface runoff from the city of Murray can have an effect on stream water quality. Without data on the effect, which is probably rather minor, the quanitation will need special investigation as part of water quality management.

F. Water Uses

Surface and ground waters in the Tennessee River Basin in Kentucky are used for Public, Industrial, Fish and Wildlife, Recreation, and Agricultural Water Supply. The groundwater in this area is generally of good quality with the exception of iron. Groundwater is the source of about 90 per cent of the public water supply in the region amounting to 2.0 million gallons per day (m.g.d.).

Due to the industrial location groundwater does not play an important role for industrial water supply. The industrial use of groundwater in the basin is 3 m.g.d. Of the 45.0 m.g.d. used in the basin for industrial purposes, about 42.0 m.g.d. (93 per cent) is supplied by the main stem of the Tennessee River.

Kentucky Lake and Barkley Lake with the Land Between the Lakes serves as a recreational area of great diversity. The water quality supports game fish, plants, and wildlife and the size of the area accommodates alarge number of people. Millions of people use Kentucky Lake for various recreational activities, and the Tennessee River is valuable for commercial fishing and mussel shells.

Water in the basin is used in the agricultural industry primarily for livestock watering with a small amount used for irrigation. There is no known area in the basin where water is restricted from use for agricultural needs.

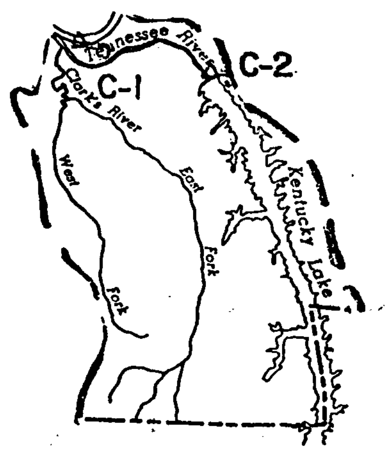
G. Water Quality Changes

The potential for water quality change, particularly within a mixing zone, occurs as a result of large scale industrial development located at Calvert City. Particular attention must be paid to compliance monitoring and special surveys to prevent any water quality deterioration from this complex. The water quality changes which can be expected are for the better as waste treatment facilities are upgraded to maintain dissolved oxygen levels above 5 mg/l. Because of the high level of recreation use of Kentucky Lake particular attention must be paid to probable waste disposal at camp sites, recreation developments, State parks, and other facilities to provide spot contamination of the lake. This control is being exercised by revising of plans and specifications for water disposal systems and the further restrictions imposed in the location of septic tanks and drain fields in relationship to the elevation of Kentucky Lake.

III. Summary

The water quality in the main stem of the Tennessee River in Kentucky is excellent. Sampling and testing in the Clarks River basin have not been sufficient to make a definite conclusion as to the water quality throughout the basin. To maintain the high water quality in the basin requires attention to industrial waste effects at Calvert City, upgrading of municipal sewage treatment plants and other small sewage treatment systems.

Treated wastes discharged from municipal, independent, and industrial sources effect the quality of the basin's streams. The need to upgrade or eliminate waste sources is being determined in the basin planning process. Another aspect of this problem is the need for improved operation and maintenance of waste treatment facilities through a program of operator licensing and education. Kentucky has instituted such programs.



○ U.S.G.S.
△ Kentucky Division of Water

TENNESSEE RIVER

10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

STATION KEY

C-1 TENNESSEE RIVER NEAR HWY 60 NE
C-2 TENNESSEE RIVER NEAR PADUCAH WPI
C-3 TENNESSEE RIVER AT KENTUCKY STATE LINE

Tennessee River Basin
Information Section

Table C-1
Population in the Tennessee River Basin by County

County	Area (sq. mi.)	1970 Pop.	Area in Basin (sq. mi.)	Pop. in Basin
Calloway	384	27,692	367	27,082
Graves	560	30,939	102	3,494
Livingston	311	7,596	39	868
Lyon	216	5,562	35	509
Marshall	303	20,381	303	20,381
McCracken	249	58,281	48	15,000 est.
Trigg	408	8,620	74	1,078
			968	68,412

Note: The information in this table was taken from the 1970 Census as reported in the Rand McNally.

Table C-2

Water Withdrawal in the Tennessee River Basin

County-City-Withdrawer	River/Lake	SW	GW	Public (mgd)	Industrial (mgd)
Calloway					
Dexter-Almo Hts. W. Dist.			x	.023	
Hamlin-G. H. Wesson			x		.146
Hazel Mncp. W. W.			x	.022	
Lynn Grove Mncp. W. W.			x	.004	
Murray Mncp. W. W.			x	1.0	.73
Lynhurst Resort, Inc.			x	.026	
Murray Bait Co.			x		.24
Murray State U.			x		.69
Graves					
Symsonia W. Dist.			x	.025	.001
Livingston					
Grand Rivers Mncp. W. W.	Ky. Lake	x		.06	
Lake City W. Dist.	Ky. Lake	x		.032	
McCracken					
Reidland W. Dist			x	.15	.008
Marshall					
Benton Mncp. Water and Sewer System			x	.32	.007
N. Marshall Co W. Dist.			x	.19	.021
Jonathan Creek Water Ass.	Ky. Lake	x		.14	
Calvert City Mncp. W. W.			x	.45	
Airco Alloys and Carbide	Tenn. R.	x			12.0
American Aniline & Extract			x		.19
B. F. Goodrich Chem. Co.	Tenn. R.	x			4.0
GAF Corp.			x		1.3
Pennwalt Chem. Corp.	Tenn. R.	x			25.0
Pittsburg Metallurgical	Tenn. R.	x			1.3
Gilbertsville Mncp. W. W.			x	.03	
Hardin Mncp. W. W.			x	.05	
Ky. Dam Village S. P.			x	.19	
Ky. Lake S. P.			x	.068	

*Mncp. W. W. - Municipal Water Works
W. Dist. - Water District
S. P. - State Park

NOTE: Data obtained from Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources.

Table C - 3

City Population and Facility Grant Status in the Tennessee River Basin in Kentucky

County	City	Population	Project Type	Comments
Calloway	Murray- Hazel	13,700 424	I	Underway
Graves	Symsonia	500	I	Underway
Livingston				
Lyon				
McCracken	San. Dist. #2-Reidland	3,500 875	I	Underway
Marshall	Benton- Hardin	3,652 522	I	Underway
	Calvert City	2,104	I	Underway
Trigg No Major Population Center in the Basin				

*These are all of the cities with a population greater than 300.

NOTE: Data obtained from Kentucky Department for Natural Resources and Environmental Protection, Division of Water Quality.

Table C-4

Water Quality Date for Tennessee River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
STORET #00400	pH (specific units Ky. Std. 6 LT pH LT 9						
Tennessee R. Hwy 60 NE	75/01/10	75/12/11	7.1	8.6	6.4	12	.739
USGS 03609750	73/11/26	74/12/03	7.3	7.6	6.6	6	.369
STORET #00095	Conductivity Micromhos Ky. Std. 800 Micro Mhos Max.						
Tennessee R. Hwy 60 NE	75/01/10	75/12/11	154.1	190.0	120.0	12	21.911
USGS 03609750	73/11/26	74/12/03	150.9	180.0	127.0	14	16.184
STORET #70300	Residue mg/l Ky. Std. 500 mg/l Max.						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	86.0	103.0	67.0	7	14.500
USGS 03609750	73/11/26	74/12/03	92.5	115.0	66.0	14	15.053
STORET #00410	Alkalinity mg/l No Standard						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	49.0	54.0	40.0	8	5.657
USGS 03609750	73/11/26	74/12/03	54.7	62.0	47.0	14	20.991
STORET #00900	Hardness mg/l 0-60 soft tl-120 moderately hard, 180 very hard						
Tennessee Hwy 60 NE	75/01/10	75/10/23	56.9	68.0	48.0	8	6.534
USGS 03609750	73/11/26	74/12/03	65.1	78.0	57.0	14	6.075
STORET #00930	Sodium mg/l No Standards						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	4.4	9.2	2.3	8	2.309
USGS 03609750	73/11/26	74/12/03	4.9	7.6	3.4	14	1.360
STORET #00935	Potassium mg/l No Standard						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	1.5	2.0	1.1	8	.091
USGS 03609750	73/11/26	74/12/03	1.6	3.2	1.0	14	.257
STORET #00940	Chloride mg/l proposed EPA Standard 250 mg/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	4.5	6.6	2.4	8	1.429
USGS 03609750	73/11/26	74/12/03	5.9	8.3	3.8	14	2.297
STORET #00945	Sulfate mg/l proposed EPA Standard 250 mg/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	9.9	12.0	7.8	8	1.619
USGS 03609750	73/11/26	74/12/03	11.8	15.0	9.3	14	1.909

Table C-4
Continued

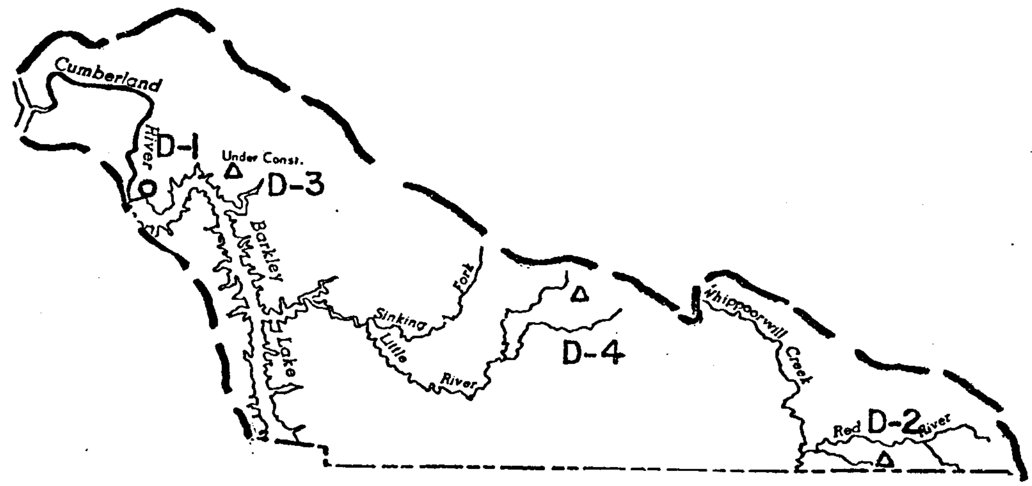
Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00950	Flouride mg/l Ky. Std. 1.0 mg/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	.125	.3	0.0	8	.104
USGS 03609750	73/11/26	74/12/03	.23	.5	.1	14	.107
STORET #00915	Calcium mg/l No Standard						
Tennessee R Hwy 60 NE	75/01/10	75/10/23	17.9	21.0	15.0	8	1.960
USGS 03609750	73/11/26	74/12/03	20.1	25.0	18.0	14	1.875
STORET #00925	Magnesium mg/l No Standard						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	2.9	3.7	2.4	8	.437
USGS 03609750	73/11/26	74/12/03	3.6	5.2	2.7	14	.725
STORET #01025	Cadmium Micorgrams per liter ug/l Ky. Std. 100 µg/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	.75	2.0	0.0	4	.957
USGS 03609750	73/12/18	74/10/18	1.0	2.0	0.0	5	1.0
STORET #01030	Chromium ug/l Proposed EPA Std. 50 ug/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	0.0	0.0	0.0	4	0.0
USGS 03609750	74/03/13	74/10/18	0.5	2.0	0.0	4	1.0
STORET #01049	Lead ug/l Ky. Std. 50 ug/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	1.0	3.0	0.0	4	1.414
USGS 03609750	73/12/18	74/10/18	3.6	9.0	0.0	5	3.286
STORET #01000	Arsenic ug/l Ky. Std. 50 ug/l						
Tennessee R. Hwy 60 NE	75/01/10	75/10/23	.75	1.0	0.0	4	0.5
USGS 03609750	73/12/18	74/10/18	.6	1.0	0.0	5	.548
STORET #31503	Total coliform colonies per 100 ml, Ky Std 1000 per 100 ml						
Tennessee R. Paducah WPI	75/01/07	75/12/16	211	1160	0	11	
Total Coliform	74/04/16	75/12/15	297	1190	0	22	

Table C-5

Organic Loads Affecting Streams in the Tennessee River Basin

Length of streams to which treated organic loads are discharged		248
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		59
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	15
	Industrial Discharges	14
	Other Discharges	30

Note: This information is from the wasteload allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q10-7) low flow.



LOWER CUMBERLAND RIVER

Base Data: U. S. Geological Survey

LOWER CUMBERLAND BASIN

The first section of this report will deal with the general description of the basin. The second section will go into a discussion of the water quality in the basin, its causes and effects.

I. Basin Description

A. Geography

The Lower Cumberland River is located in Western Kentucky. The confluence with the Ohio River is at the town of Smithland, Kentucky. The Kentucky-Tennessee border is at mile point 74.7 on the Cumberland River. The area of this portion of the drainage basin in Kentucky is 1,900 sq. mi. of a total drainage basin area of 17,900 sq. mi. This basin contains all or portions of 9 Kentucky counties which are listed in Table D-1. There are two major sub-basins in this region, namely the Little River with 601 sq. mi. and the Red River with a total drainage basin area of 1,460 sq. mi. of which 688 are in Kentucky. At mile point 30.3 Barkley Lock and Dam forms Barkley Lake with a pool 118 miles in length, 44 miles of which are in Kentucky.

B. Topography

The topography of the Lower Cumberland River Basin is composed of gently rolling plains and "Karst" areas. Karst topography is characterized by sinkholes, underground solution channels and caves.

Stream slopes affect the rate at which dissolved oxygen levels are replenished. Stream slopes of 2 feet per mile and less have low reaeration rates, slopes of 2 feet per mile to 6 feet per mile have moderate reaeration rates, and slopes of 6 feet per mile and greater have higher reaeration rates. The main stem of the Cumberland River below Barkley Lake has a slope of 5.7 feet per mile to the point where Livingston Creek enters the Cumberland River. The slope is very low from Livingston Creek to the Ohio River. Of the major tributaries listed in Table D-2, three (based on slope only) have low reaeration rates, five have moderate reaeration rates and fourteen have high reaeration rates. Many of the tributary streams have a low slope near the confluence with the Cumberland River which can present special problems in maintaining dissolved oxygen levels of 5 milligrams per liter (mg/l).

In the Lower Cumberland Basin stream elevations in the headwaters rise to 600 feet above mean sea level (m.s.l.). The elevation is 302 feet at the Ohio River.

C. Geology

The principal geological feature of this basin contributing to surface water quality is the limestone parent material. Limestone underlies the entire basin with the exception of the Livingston County portion which is part of a fluoropsar district along the Ohio River. The limestone base parent material contributes to the hardness of the groundwater which ultimately contributes to the hardness of the surface water.

The limestone parent material does not provide high yielding aquifers. Groundwater reserves are moderate to low throughout the basin. In approximately 80 per cent of the basin, wells produce 50 g.p.m. or less and the remaining wells produce 50-500 g.p.m.

D. Hydrology

The Cumberland River is a highly developed river system with a series of locks and dams which permit navigation upstream for 380 miles. The river above this point is further regulated by dams for multiple purpose control, principally flood, recreation and power. There are three lakes in this portion of the basin with surface areas of over 100 acres: Lake Barkley with 57,900 acres, Lake Morris with 170 acres and Lake Boxley with 166 acres. Lake Barkley is regulated for navigation, flood, power, recreation and fish and wildlife purposes. The Kentucky-

Barkley canal at mile point 32.7 permits navigation between Barkley and Kentucky Lake and provides for flow regulator.

The USGS flow gauging stations data at Little River at Cadiz in Trigg County and the Cumberland River at Grand Rivers in Lyon County is tabulated below. The Little River enters Barkley lake 59 miles from the Ohio River and drains an area of 244 sq. mi. The gauging station at Grand Rivers measures the flow through Barkley Lake and drains an area of 17,600 sq. mi. Occasionally the flow from Barkley Dam is stopped for operating and maintenance of the facilities for periods which do not exceed seven days.

E. Population

The population of the Lower Cumberland Basin in Kentucky is predominately rural. Small communities are located along the main stem and many of the smaller tributaries. The county with the largest population is Christian County with 56,224 persons. The city of Hopkinsville in Christian County has a population of 21,409. The other municipality with a population over 2,000 is Princeton with 6,292 population. The total basin population is 92,380 of which 45 per cent is urban and 55 per cent is rural.

TABLE D-8

SURFACE WATER RECORDS FOR THE LOWER CUMBERLAND RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Little River at Cadiz	35 yr.	244 sq.mi.	343 cfs, 1.4cfs*/sq.mi.	19,400 cfs, 80 cfs/sq.mi.	1 cfs, 0.0cfs/sq.mi.	0.06 cfs
	wtr/yr 1975		545 cfs, 2.2cfs/sq.mi.	10,000 cfs, 41 cfs/sq.mi.	34 cfs, 0.1cfs/sq.mi.	
Cumberland River at Grand Rivers	25 yr.**	17,598 sq.mi.	27,510 cfs, 1.6cfs/sq.mi.	201,000 cfs, 11 cfs/sq.mi.		620 cfs
	10 yr.**		38,800 cfs, 2.2cfs/sq.mi.	209,000 cfs, 12 cfs/sq.mi.		
	wtr/yr 1975		52,720 cfs, 3.0cfs/sq.mi.	202,000 cfs, 11.5cfs/sq.mi.	6,600 cfs, 0.4cfs/sq.mi.	

* Cubic feet per second

** 25 Years (1940-1965), prior to opening of Barkley-Kentucky Canal.
10 Years (1965-1975), since opening of Barkley-Kentucky Canal.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

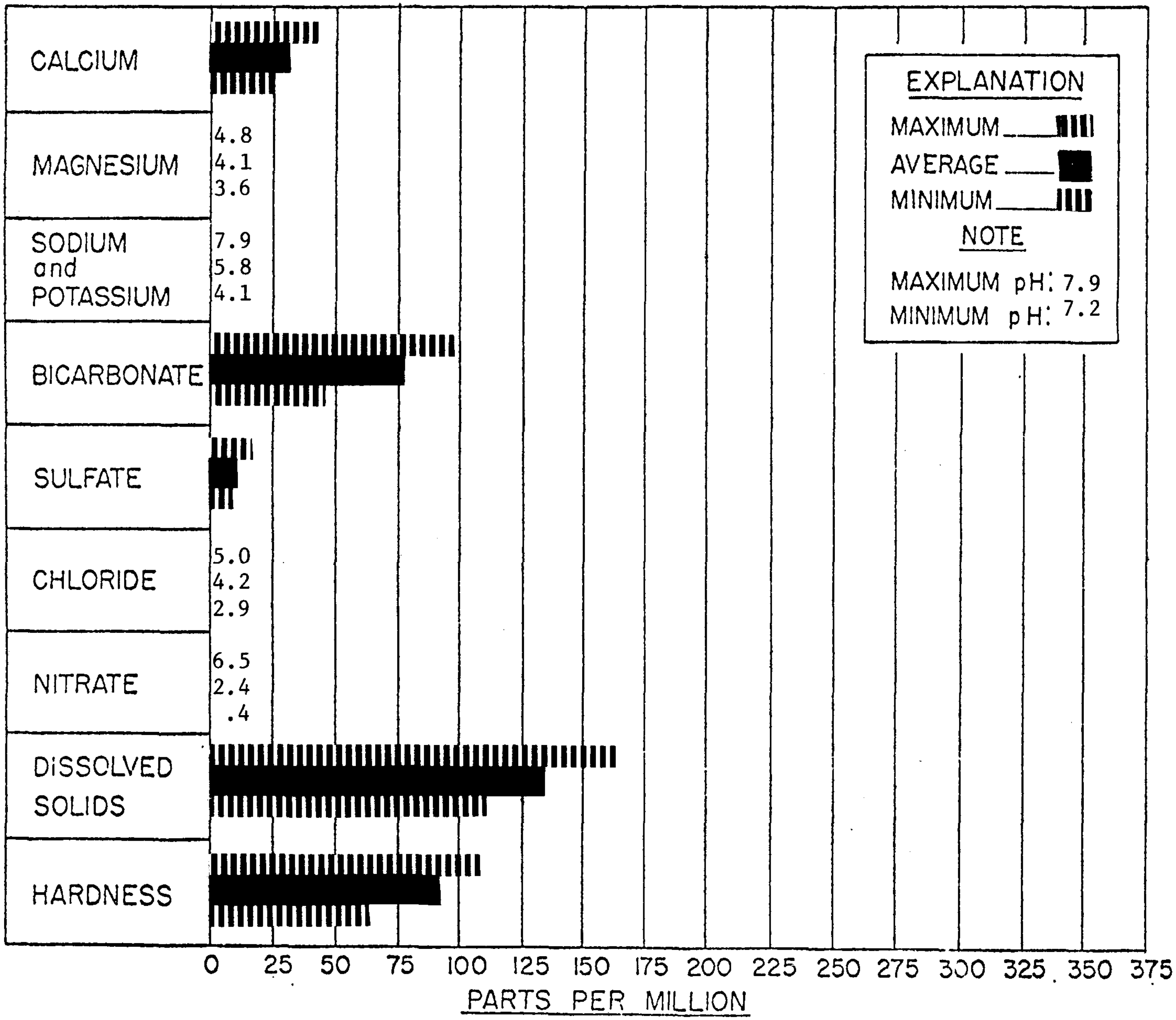
A. Description of Sampling Stations

Two sampling stations were chosen to characterize the water quality for the Lower Cumberland River Basin. The USGS gauging station was on the Cumberland River at Grand Rivers below Barkley Lake. The total drainage area above this station 17,598 square miles. The Kentucky Water Quality station used was the Princeton water plant intake on Barkley Lake in Caldwell County.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is of moderate hardness caused by calcium and magnesium salts. The influence of mining activities is clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

Two stations were selected to characterize the general chemical water quality in the Lower Cumberland River Basin. The data for the stations selected was retrieved in a manner to delete extreme values not characteristic of the basin water quality. The water



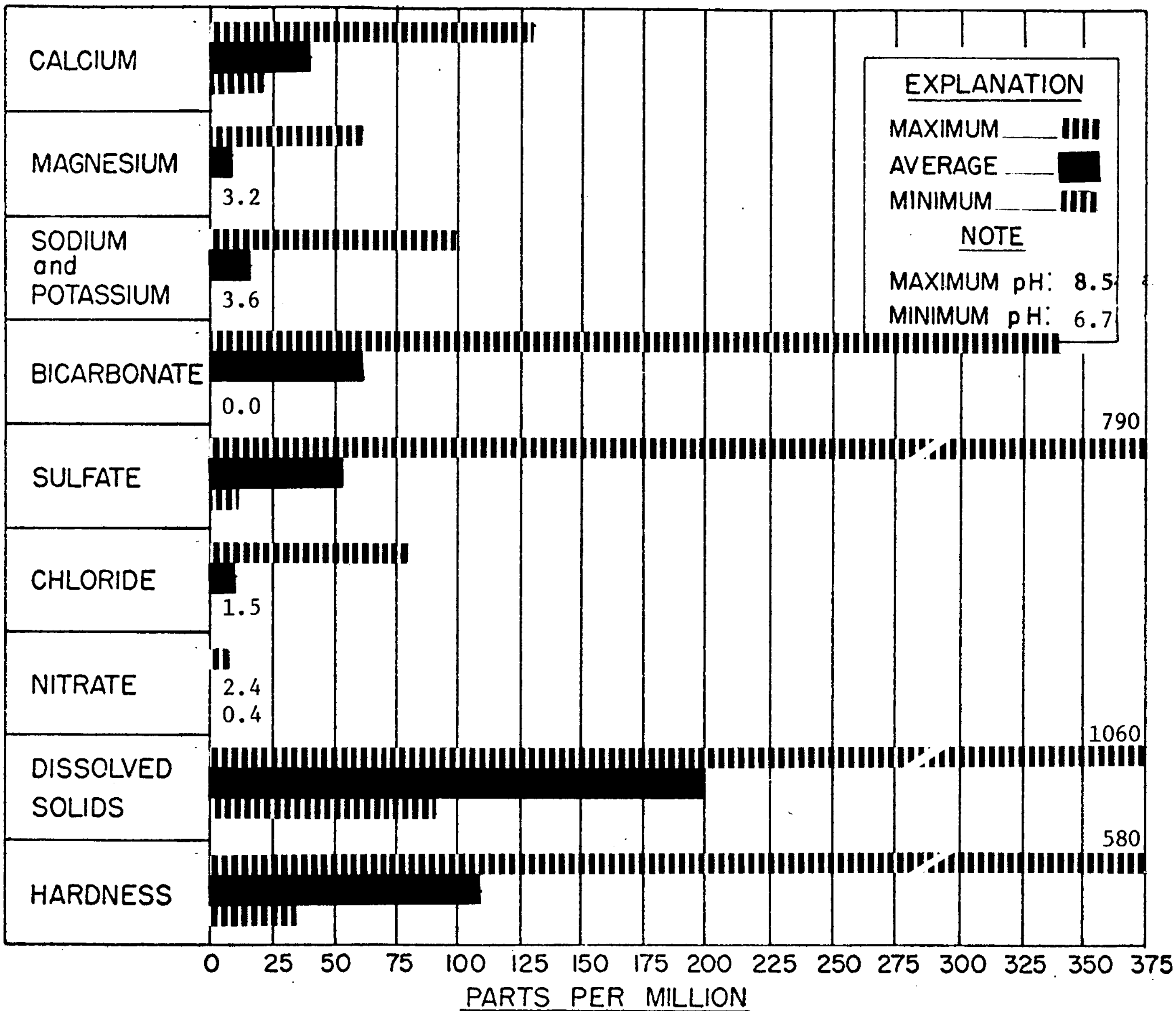
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE D-1

Lower Cumberland River

Grand Rivers

11-73 to 12-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE D-2

Lower Cumberland

Grand Rivers

8-66 to 12-74

quality in the Cumberland River Basin is reflective of the same water quality as that in the Tennessee River below Kentucky Dam since the canal permits free interchange of water between the two lakes.

C. Trace elements (under 5 mg/l) are separated from the general chemical background of this report because on their influence on human health. Generally, these materials are "heavy" metals which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State and Federal Water Quality Standards.

All trace chemicals measured in the Lower Cumberland Basin with the exception of lead and chronimum were within Kentucky-Federal Water Quality Standards. Average values for all trace chemicals including lead and chronium were within Kentucky-Federal guidelines. The value for lead exceeded the limit one time; the level being .07 mg/l as compared with the standard of .05 mg/l. The value for chromimum is for total chromimum rather that the hexa-valent chromimum and the level of exceedence at .11 mg/l is not sufficient to warrent further investigation.

D. Waste Load Affect on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such waste loads are considered to have an affect on stream quality when they cause the dissolved oxygen (D.O.) levels to drop below Kentucky Water Quality Standards of 5 mg/l.

Using a model developed in conjunction with the River Basin Planning Process, 360 miles of streams with waste loads in the Lower Cumberland Basin were studied. Of this total, 17.3 per cent or 62.2 miles were shown to have loads in 1975 which would cause the D.O. levels to be below 5 mg/l at a low flow occurance of once in 10 years for 7 days.

The type of waste and the distance affected in this basin where D.O. levels are less than 5 mg/l, are municipal discharges 40 miles or 11% of the total and other discharges (hospitals, mobile home parks, and schools) 22 miles or 6 %.

E. Non-Point Source Effects

The major non-point pollutants from the portion of Kentucky that drains directly into the Cumberland River are sediment, animal waste, and solid waste.

Sources of excessive sediment areas were identified in an inventory of critically eroding areas prepared in 1974 by the USDA Soil Conservation Service. About 122 square miles (sq. mi.) of cropland were judged to have excessive erosion rates. An estimated 44 sq. mi. of forest land have excessive erosion as a result of logging operations, burning, and grazing.

F. Water Uses in the Basin

Most of the surface water withdrawn in this basin is for public uses. Of the total surface water used, 4.8 million gallons per day were used for municipal purposes. Industrial uses of surface water amounts to 563,000 gallons per day. A complete breakdown of water uses, both surface and groundwater, by industries and municipalities is shown in Table D-8.

At the present time, agricultural uses of surface water supplies is primarily livestock watering. It can be expected that use of surface waters for irrigation will increase in the future.

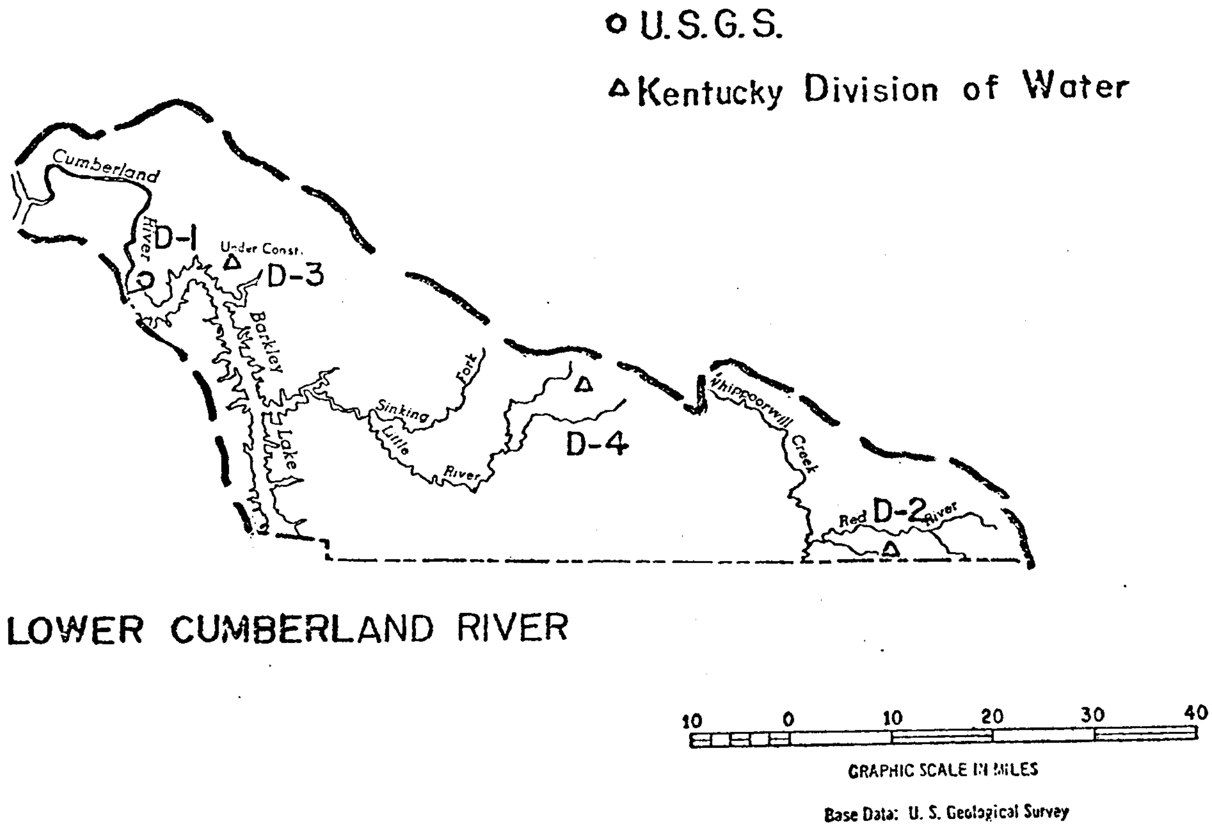
Barkley Lake in the Lower Cumberland River Basin and Kentucky Lake in the Tennessee River Basin provide a great variety of water related activities. Barkley Lake is the largest lake in the Cumberland River system. Lake Barkley State Resort Park at Cadiz, Kentucky and the Land-Between-the-Lakes provides for both water and non-water recreational activities year round.

G. Water Quality Changes

The water quality in the Lower Cumberland River Basin in the main stem and Barkley Lake is of uniform excellent quality. This conclusion is derived from a few values from STORET data which were known to be from the main stem of the Cumberland River and from the information presented in the Tennessee River Basin Report. Both of these rivers are interconnected by canal and, therefore, share similar water quality. As far as tributary streams to the Cumberland River, the changes expected will be for upgrading waste treatment facilities with an accompaning improvement for water quality and better control of land use practices particularly agricultural uses to minimize the effects of soil erosion. The Soil Conservation Service has identified a particular area of concern and cooperative efforts of the Division of Water of the Department for Natural Resources and Environmental Protection with the Soil Conservation Service will produce the necessary control to minimize the effect of sedimentation in the tributary streams.

III. Summary

The unique features of the Lower Cumberland Basin include a large recreation area which is associated with Barkley Lake, Kentucky Lake and the Land-Between-the-Lakes. This recreational potential must be given high priority for the protection of localized contamination from waste facilities and for control of sediment loads to prevent siltation of embayment areas. The other feature which contributes to water quality changes is the "Karst" topography which increases hardness in tributaries and makes groundwater from solution channels and pools within caverns difficult to protect from bacterialogical contamination. In these areas groundwater is of questionable bacterialogical quality and extension of rural water supplies providing treated water should be encouraged.



LOWER CUMBERLAND RIVER

STATION KEY

D-1 CUMBERLAND RIVER AT GRAND RIVERS
D-2 RED RIVER AT ADAIRVILLE WPI
D-3 LAKE BARKLEY AT EDDYVILLE WPI
D-4 NORTH FORK LITTLE RIVER AT HOPKINSVILLE

Table D-1

Drainage Areas in the Lower Cumberland Basin

AREA DATA

COUNTY	TOTAL AREA	PERCENT AREA IN BASIN	AREA IN BASIN IN SQUARE MILES
Caldwell	357	44.7	160
Christian	726	63.6	462
Crittenden	365	21.8	80
Livingston	317	37.8	120
Logan	563	39.4	222
Lyon	254	83.8	213
Simpson	239	39.9	95
Todd	376	64.3	242
Trigg	457	83.1	380
		Total,	1,933

Source: This information was taken from Kentucky Water Quality Standards for Interstate Waters, Kentucky Water Pollution Control Commission, June, 1967.

Table D-2

Slope and Elevations of Streams in the Lower Cumberland Basin

Slopes

CREEK	AVERAGE(feet/mile)	ELEVATIONS Head	Mouth
South Fork Red River	5.28	530	468
Elk Fork	6.64	650	470
Big West Fork	6.44	600	400
Red River	4.4	600	450
South Fork Little River	7.58	660	475
Caney Creek	26.18	448	359
Little River	2.39	550	359
Dry Creek	15.17	450	362
Eddy Creek	4.15	450	359
Hammond Creek	27.9	490	359
Caldwell Springs	20.0	373	329
Crab Creek	17.87	428	319
Panther Creek	20.55	420	307
Livingston Creek	2.37	329	302
Cox Spring Branch	35.7	426	355
Sandy Creek	5.31	319	302
Clear Branch	22.0	330	319
Knob Creek	21.3	393	359
Lick Creek	4.4	370	359
Blue Spring Creek	0	359	359
Montgomery Creek	15	620	461
McCornick Creek	19.35	332	302

Note: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning Effort.

Table D-3

Lakes in the Lower Cumberland River Basin

LAKES	VOLUME (Acre-Feet)	AREA(Acres)
Morris - North Fork Little River	1740	170.0
Boxley - North Fork Little River	2006	166.0
Blythe - North Fork Little River	1313	89.0
Barkley - Cumberland River	259,000	57,920

Source: Kentucky Department for Natural Resources and Environmental Protection Division of Water Resources.

Table D-4

Population in the Lower Cumberland Basin by County

COUNTY	TOTAL POPULATION IN COUNTY IN 1970 ***	POPULATION IN BASIN*
Caldwell	13179	9619
Christian	56224	43378
Crittenden	8493	1196
Livingston	7596	3762
Logan	21793	5919
Lyon	5562	5055
Simpson	13054	2594
Todd	10823	8140
Trigg	8620	7499
		87162

* Population in basin is found by taking rural population evenly distributed across the county and multiplying by percentage of area of the county in the basin. City populations are then added to this figure.

*** 1970 U.S. Census Data from Rand McNally Standard Reference Map and Guide of Kentucky.

Table D - 5

City Population and Facility Grant Status in the Lower Cumberland River Basin in Kentucky

City	County	Population	Project Type	Comments
Caldwell	Princeton	6,292	I	Underway
	Fredonia	450	I	Pending
Christian	Hopkin	21,400	I	Underway
	Pembroke	634	None	Sewered
Crittenden				
Livingston	Smithland-	514	I	Pending
	Ledbetter	15		
	Salem	480	I	Underway
	Grandrivers	438	I	Underway
Logan	Adairville	973	I	Underway
Lyon	Eddyville	1,981	III	Underway
	Kuttawa	453	None	Sewered
Simpson				

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminar studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments related to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U. S. Census and the FY 75 Construction Grants List for Kentucky.

Table D-6

Water Uses in Lower Cumberland River Basin

	Total (gpd)	Well (gpd)	Surface (gpd)
Municipal	5,210,000	395,000	4,820,000
Industrial	1,095,000	532,000	563,000

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources.

Table D- 7

Organic Loads Affecting Streams in the Lower Cumberland Basin

Length of streams to which treated organic loads are discharged		360 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		62 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	40 miles
	Other Discharges	22 miles

Note: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning effort. The values indicated the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q 10-7) low flow.

Table D-8

Water Quality Data for Lower Cumberland Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00400	pH Specific Units Kentucky Standard 6 LT pH LT 9						
Cumberland River-	75/02/12	76/01/13	6.9	7.7	6.4	12	.392
Grand River	74/07/15	74/12/02	7.5	7.9	7.2	4	.294
U.S.G.S. 03438220	66/01/19	73/12/18	7.5	8.5	6.7	28	.372
STORET # 00095	Conductivity Micro mho, Ky. Std. 800 Micro mhos						
Cumberland River-	75/02/12	76/01/13	184.2	230.0	145.0	12	27.1
Grand River	74/07/15	74/12/02	195.5	229.0	163.0	6	23.8
U.S.G.S. #03438220	66/01/19	74/05/06	188.7	239.0	138.0	43	22.4
STORET #70300	Dissolved Solids mg/l, Ky. Std. 500 mg/l						
Cumberland River-	75/02/12	75/10/21	101.7	124.0	86.0	7	15.6
Grand River	74/07/15	74/12/02	135.8	162.0	106.0	6	20.9
U.S.G.S. #03438220	66/01/19	74/05/06	112.1	154.0	94.0	32	14.3
STORET #00410	Alkalinity mg/l No Standard						
Cumberland River-	75/02/12	75/10/21	64.1	84.0	53.0	7	10.9
Grand River	74/07/15	74/12/02	79.3	96.0	66.0	6	12.7
U.S.G.S. #03438220	67/11/30	74/05/06	66.7	82.0	56.0	29	7.1
STORET #00900	Hardness mg/l, 0-60 Soft, 61-120 MOD, Hard, 121-180 Hard, 180 + Very Hard						
Cumberland River-	75/02/12	75/01/21	77.6	97.0	63.0	7	13.0
Grand River	74/07/15	74/12/02	94.3	110.0	78.0	6	10.6
U.S.G.S. #3438220	66/01/19	74/05/06	84.0	110.0	68.		10,1
STORET #00935	Potassium mg/l No Standard						
Cumberland River-	75/02/12	75/10/21	1.3	1.8	1.1	7	.243
Grand River	74/07/15	74/12/02	1.6	1.8	1.1	6	.259
U.S.G.S. #03438220	66/08/08	74/05/06	1.5	2.4	1.2	13	.330
STORET #00940	Chloride mg/l Proposed E.P.A. Std. 250 mg/l						
Cumberland River-	75/02/12	75/10/21	2.9	4.0	1.7	7	.890
Grand River	74/07/15	74/12/02	4.2	5.0	2.9	6	.873
U.S.G.S. #03438220	66/01/19	74/05/06	5.3	13.0	2.3	32	2.9

Table D-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00945	Sulfate mg/l Proposed E.P.A. Std. 250 mg/l						
Cumberland River-	75/02/12	75/10/21	13.4	17.0	10.0	7	2.7
Grand River	74/07/15	74/12/02	15.2	18.0	12.0	6	2.3
U.S.G.S. #03438220	66/01/19	74/05/06	17.8	24.0	13.0	32	2.5
STORET #00618	Nitrate - N mg/l, Proposed E.P.A. Std. 10 mg/l						
Cumberland River- Grand River U.S.G.S. #03438220	72/01/25	72/08/09	.80	.84	.70	3	.072
STORET #00950	Flouride mg/l Kentucky Std. 1.0 mg/l						
Cumberland River-	75/02/12	75/10/21	.16	.4	0.0	7	.151
Grand River	74/07/15	74/12/02	.13	.4	.1	6	.052
U.S.G.S. #03438220	66/01/19	74/05/06	.25	1.2	.1	17	.265
STORET #00915	Calcium mg/l No Standard						
Cumberland River-	75/02/12	75/10/21	25.1	32.0	20.0	7	4.7
Grand River	74/07/15	74/12/02	30.3	39.0	25.0	6	5.1
U.S.G.S. #03438220	66/08/08	74/05/06	26.1	34.0	21.0	13	3.4
STORET #00925	Magnesium mg/l No Standard						
Cumberland River-	75/02/12	75/02/12	3.6	4.2	3.1	7	.427
Grand River	74/07/15	74/12/02	4.1	4.8	3.6	6	.440
U.S.G.S. #03438220	66/08/08	74/05/06	4.0	5.1	3.2	13	.665
STORET #01025	Cadmium Micrograms/Liter Kentucky Std. 10ug/l						
Cumberland River-	75/04/16	75/10/21	3.3	10.0	0.0	3	5.7
Grand River	74/08/07	74/10/15	1.5	2.0	1.0	2	.707
U.S.G.S. #03438220	3/05/03	74/03/11	1.0	2.0	0.0	4	.816
STORET #01056	Manganese ug/l Proposed Kentucky Std. 50 ug/l						
Cumberland River-	75/04/16	75/10/21	11.3	20.0	4.0	3	8.0
Grand River	74/08/07	74/10/15	0.0	0.0	0.0	2	0.0
U.S.G.S. #03438220	72/01/25	74/03/11	52.6	200.0	0.0	7	70.4

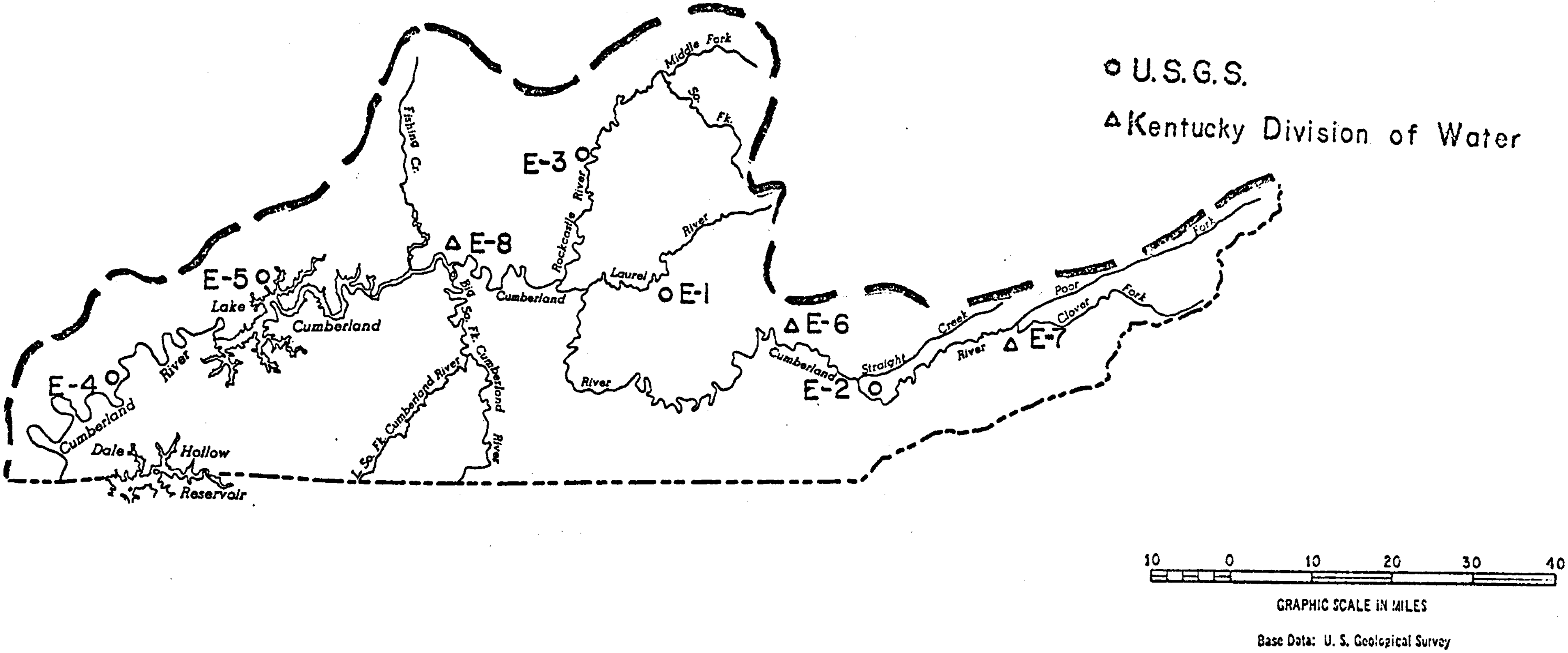
Table D-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #01046	Iron u g/l Proposed E.P.A. Std. 300 u g/l						
Cumberland River-	75/04/16	75/04/16	30.0	50.0	10.0	3	20.0
Grand River	74/08/07	74/10/15	15.0	30.0	0.0	2	21.2
U.S.G.S. #03438220	72/01/25	74/03/11	64.3	250.0	0.0	7	88.9
STORET #01030	Chromium u g/l, Kentucky Std. 50 u g/l						
Cumberland River-	75/04/16	75/10/21	0.0	0.0	0.0	3	0.0
Grand River	74/08/07	74/10/15	0.0	0.0	0.0	2	0.0
U.S.G.S. #03438220	73/05/03	74/03/11	0.0	0.0	0.0	4	0.0
STORET #01049	Lead ug/l, Kentucky Std. 50 u g/l						
Cumberland River-	75/04/16	75/10/21	.67	2.0	0.0	3	1.1
Grand River	74/08/07	74/10/15	4.5	7.0	2.0	2	3.5
U.S.G.S. #03438220	73/05/03	74/03/11	6.75	12.0	0.0	4	5.1
STORET #01000	Arsenic ug /l Kentucky Std. 50 u g/l						
Cumberland River-	75/04/16	75/10/21	.67	1.0	0.0	3	.577
Grand River	74/08/07	74/10/15	0.0	0.0	0.0	2	0.0
U.S.G.S. #03438220	73/05/03	74/03/11	1.75	5.0	0.0	4	2.3
	Kentucky Standard Total Coliform 1000/100 ml						
Total Coliform	Colonies per 100 ml. STORET #31503						
Fecal Coliform	Colonies per 100 ml. STORET #31616						
Red River,	75/1/07	75/12/15	1147	786	10200	12	
Adairville WPI	74/04/16	75/12/15	4356	36700	0	23	
T. Coliform							
F. Coliform	75/10/22	75/12/15	314	600	53	3	
Lake Barkley,	75/01/07	75/12/16	87	400	0	11	
Eddyville WPI	74/04/16	75/12/16	148	776	0	21	
T. Coliform							

Table D-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
N. Fork Little River Hopkinsville T. Coliform	75/01/07 74/04/15	75/12/17 75/12/17	786 2471	3300 12266	4 4	12 22	
F. Coliform	75/10/22	75/10/22	267	267	267	1	

UPPER CUMBERLAND RIVER



THE UPPER CUMBERLAND RIVER BASIN

The Upper Cumberland River Basin is of considerable historic significance to Kentucky. It is through Cumberland Gap near Middlesboro that Doctor Walker first came to the state in 1757. Daniel Boone also entered Kentucky from Virginia through Cumberland Gap and made his trek through most of the Lower Cumberland finally establishing settlements at Boonesboro on the Kentucky River. Much of the Upper Cumberland River Basin is relatively undisturbed with a wild river designated in the South Fork of the Cumberland River.

I. Basin Description

A. Basin Description

The Cumberland River originates at Harlan, Kentucky at the confluence of Poor Fork and Clover Fork 694 miles from its confluence with the Ohio River. The flow is generally in a westerly direction turning south below Lake Cumberland before flowing into Tennessee. The total basin drainage area in Kentucky is 5,077 sq. mi. with eight (8) sub-basins consisting of 200 sq. mi. or more.

B. Topography

The topography varies from mountainous in the upper portion or headwaters of the basin to hilly, with steep cliffs along the stream courses in the lower portion. Big Black Mountain, located in Harlan County is the highest elevation in Kentucky at 4,145 feet above sea level. The average slope of the streams in the entire basin is 14 feet per mile with the main stem above Lake Cumberland averaging approximately seven feet per mile (ft./mi.).

C. Geology

Most important of the geological features which affects water quality is the extensive coal deposits found at the upper region and throughout the majority of the entire basin. The middle portion of the basin, also, consists of high-calcium limestone deposits which lends to the hardness of the water. Petroleum producing areas and refineries are found in the lower portion of the basin and always possess the potential for oil spills or leaks. These are rare, but have a tremendous shock affect when they occur.

D. Hydrology

The average flow of the main stem of the Cumberland River in Kentucky is 5,790 cubic feet per second with an average yield of 1.67 cubic feet per square mile (See Table E-4). There exists ten (10) major lakes in the basin all possessing flood control capabilities and comprising a total surface area of 102,315 acres. Three of these lakes are Corps of Engineers' projects - Lake Cumberland, Laurel River and Dale Hollow Lake - with total surface area of 100,580 acres. Lake Cumberland is the largest of the lakes with an area of 63,530 acres and is used for power, recreation, and flood control purposes.

E. Population

Population in the basin can best be described as scattered. The total population in the basin is approximately 260,000 people based on 1970 census. The majority of the population is rural. The only two cities greater than 10,000 people are Middlesboro with 11,700 and Somerset with 10,500 (1970 census). Of the entire basin population, 25 per cent reside in Harlan and Bell counties which are located near the headwaters of the basin, and 77 per cent reside in the portion above Lake Cumberland. The portion of the population in headwaters is due to coal mining.

TABLE E-4

SURFACE WATER RECORDS FOR THE UPPER CUMBERLAND RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Cumberland River near Rowena**	36 yr.	5,790 sq.mi.	9,128 cfs, 1.6cfs*/sq.mi.	162,000 cfs, 28 cfs/sq.mi.	0 cfs	93 cfs
	wtr/yr 1975		13,400 cfs, 2.3cfs/sq.mi.	41,700 cfs, 7 cfs/sq.mi.	112 cfs, 0.0cfs/sq.mi.	
Cumberland River at Cumberland Falls	65 yr.	1,977 sq.mi.	3,203 cfs. 1.6cfs/sq.mi.	59,600 cfs, 30 cfs/sq.mi.	4 cfs, 0.0cfs/sq.mi.	26 cfs
	wtr/yr 1975		4,414 cfs, 2.2cfs/sq.mi.	50,500 cfs, 26 cfs/sq.mi.	117 cfs, 0.1cfs/sq.mi.	
Cumberland River near Harlan	35 yr.	374 sq.mi.	693 cfs, 1.9cfs/sq.mi.	43,200 cfs, 116cfs/sq.mi.	3 cfs, 0.0cfs/sq.mi.	20 cfs
	wtr/yr 1975		928 cfs, 2.5cfs/sq.mi.	16,000 cfs, 43 cfs/sq.mi.	19 cfs, 0.1cfs/sq.mi.	

* Cubic feet per second

** Flow regulated by Lake Cumberland beginning March 1950.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

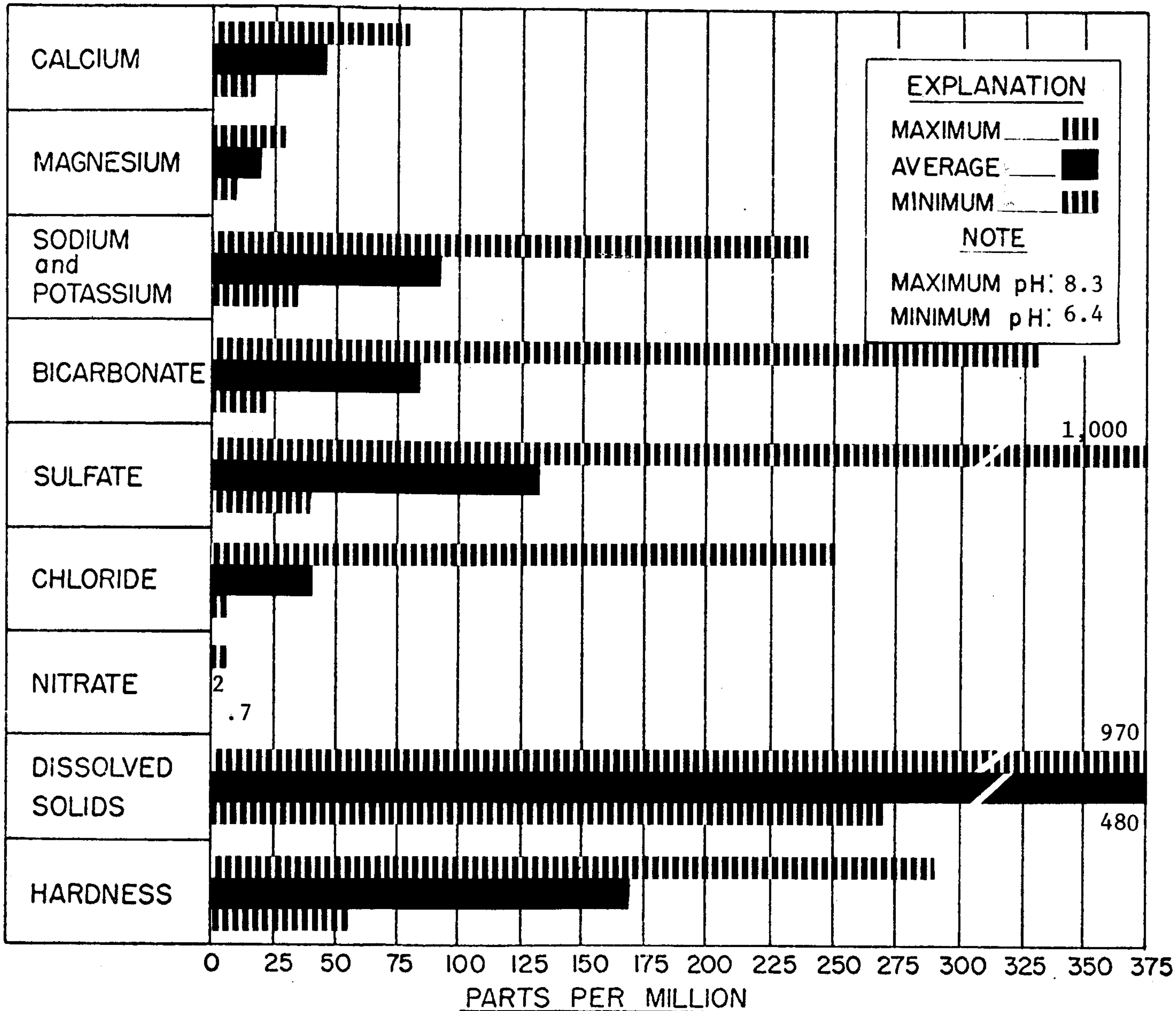
A. Description of Sampling Stations

Data for which the discussion of water quality in this report is based was collected from four sampling stations. Three of these stations are located on the Cumberland River itself at (1) Harlan, (2) Barbourville, and one below Lake Cumberland at (3) Burkesville. The fourth is located on the Yellow Creek at Middlesboro selected to reflect the effects of a coal mining area and an industrial waste discharge. Total drainage area encompassed by these stations, including the portion in Tennessee, is 6,152 sq. mi. with the Harlan station, 374 sq. mi., the Middlesboro station, 103 sq. mi., Barbourville, 1,034 sq. mi., and Burkesville, 6,152 sq. mi.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts. The influence of mining activities is clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

The general chemical water quality of the Upper Cumberland River Basin is characterized by Figures E-2 through E-5 which indicate a water with moderate mineralization as reflected by the hardness on E-2 and the combination of calcium and magnesium on E-4 which results in the equivalent hardness as shown in Burkesville.



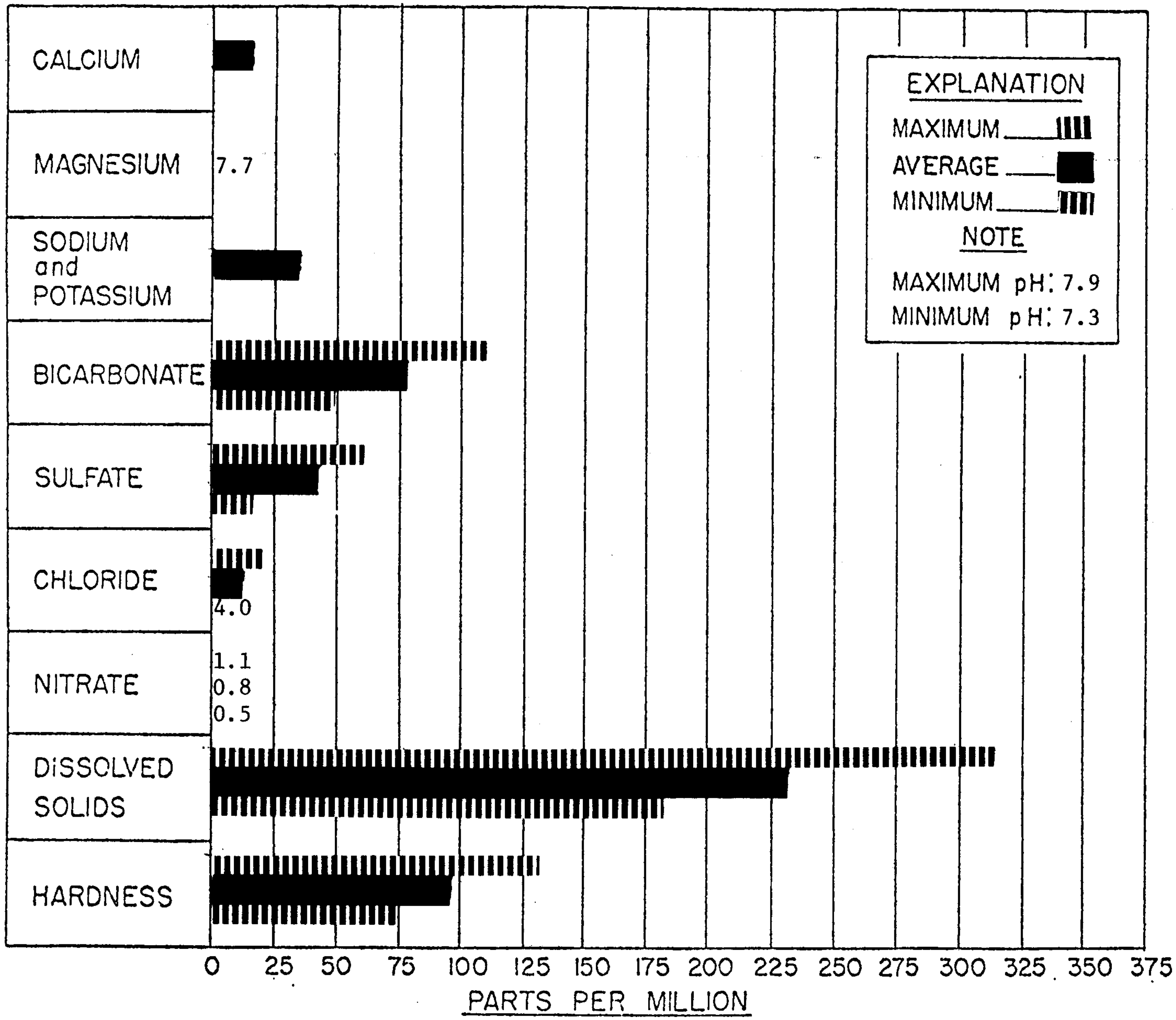
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE E-1

Yellow Creek

Middlesboro

5-64 to 11-74



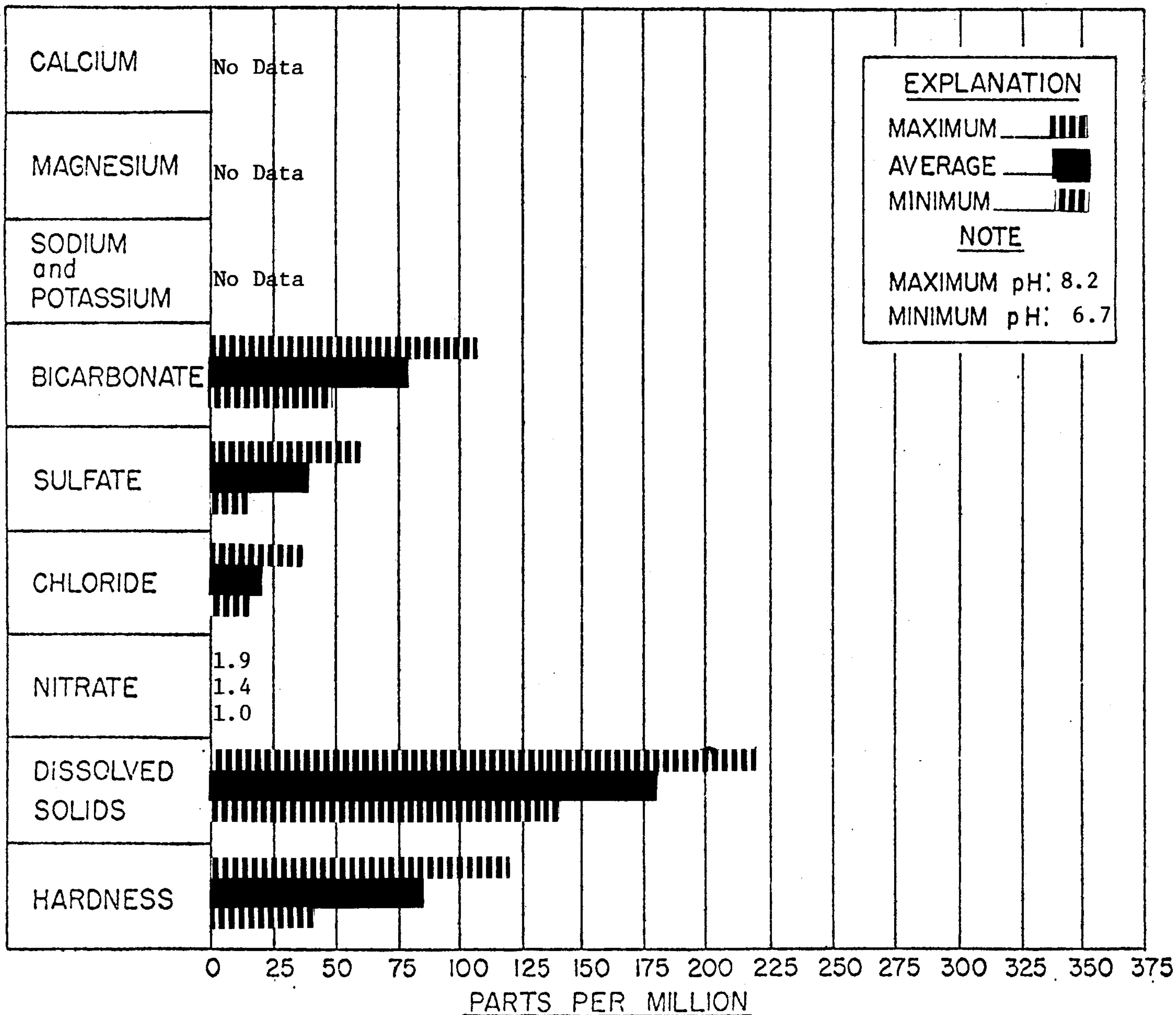
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE E-2

Cumberland River

Pineville

5-60 to 9-72



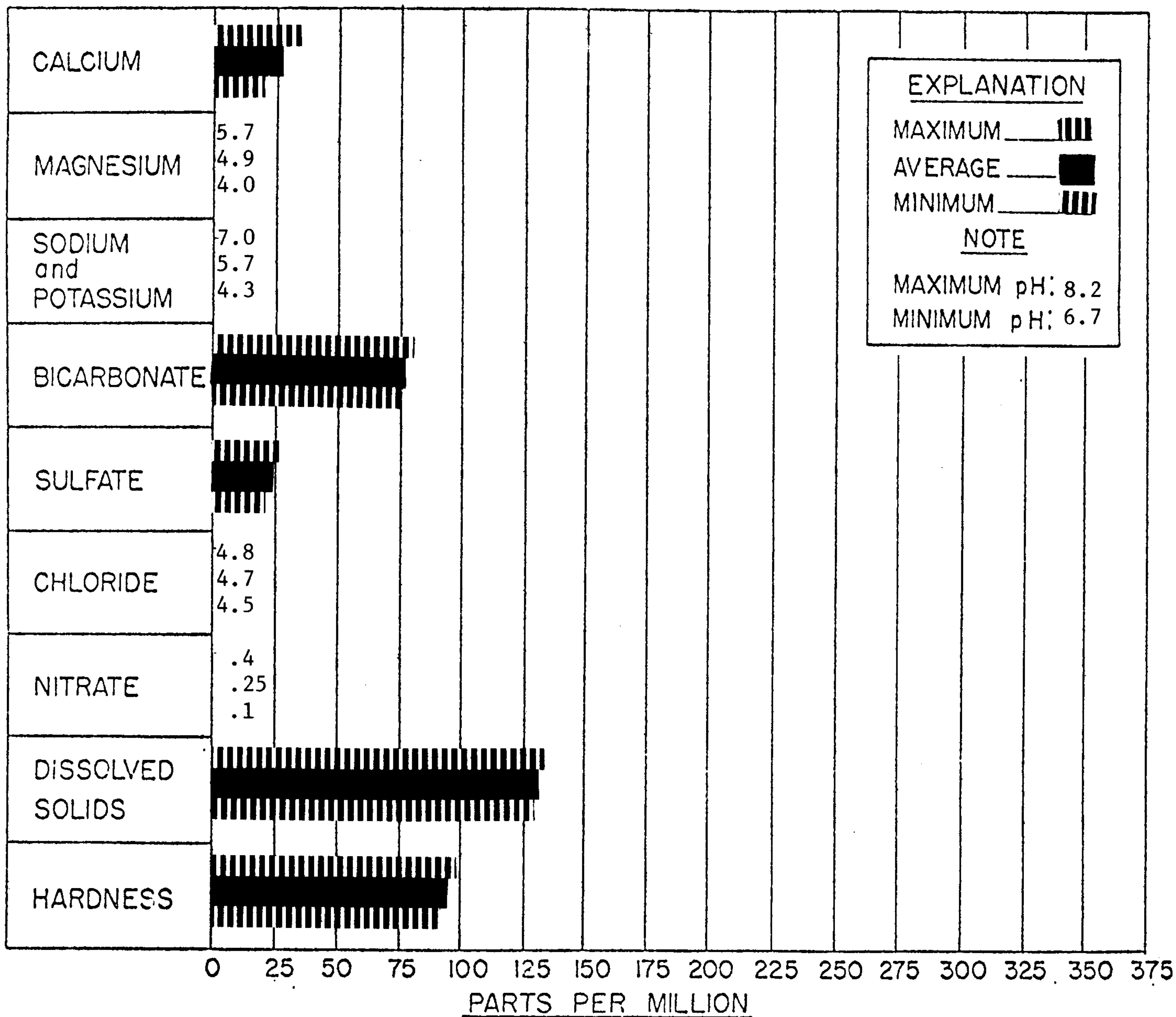
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE E-3

Laurel River

Corbin

10-65 to 9-72



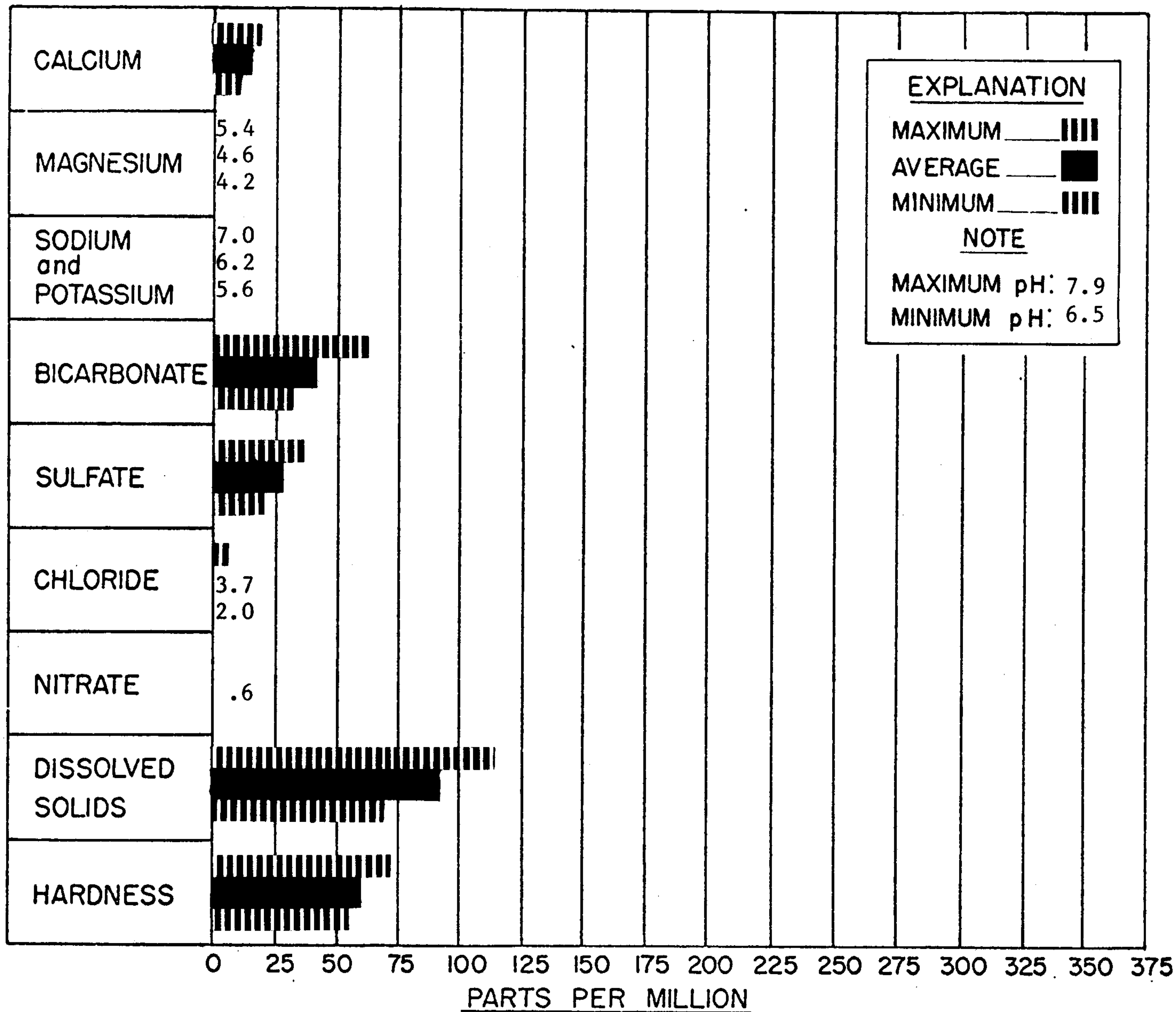
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE E-4

Rockcastle River

Billows

5-60 to 12-75



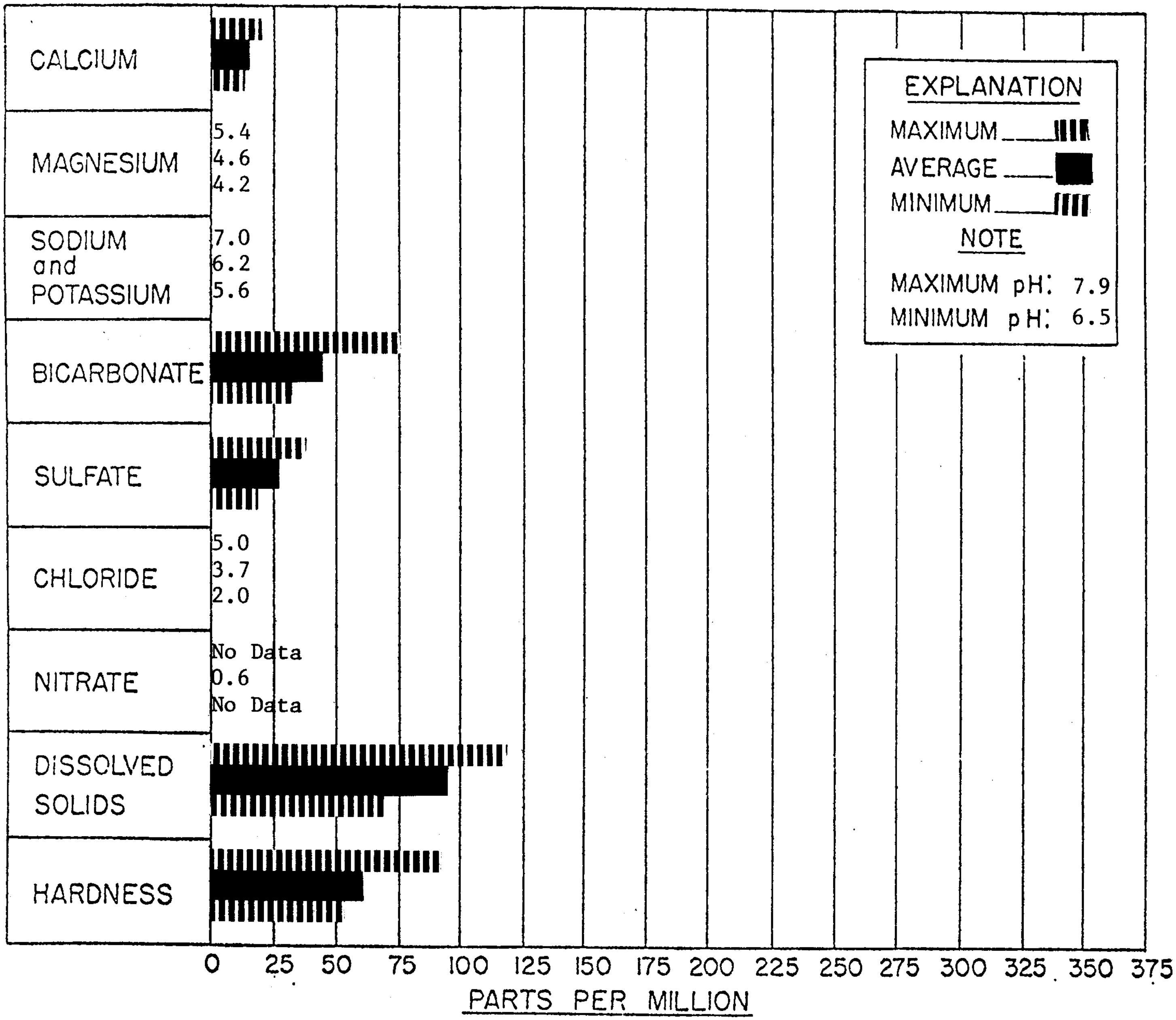
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE E-5

Cumberland River

Burkesville

12-65 to 5-72



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE E-6

Cumberland River

Burkesville

12-65 to 5-72

The water quality shown on Yellow Creek is not typical of the river as a whole but was selected to indicate the effect of natural conditions and man-made conditions on water quality. The source of water quality of Yellow Creek is an impoundment known as Fern Creek some 1,000 feet above the city of Middlesboro. Middlesboro is situated in a geological structure. This area is filled with sedimentation containing a high amount of organic material and as a result of seepage from this material, high sulfates, tannins, lignens, and low D.O. upstream of any waste discharges cause a major modification of the water from Fern Lake which has very little mineralization.

The city of Middlesboro, in addition to treating the municipal waste, has a facility which treats tannery wastes which compounds the problem of increasing the mineralization and particularly the sodium chloride portion. The effects of coal mining will particularly be exhibited on Yellow Creek in Middlesboro in spite of the fact that the sulfate concentration is relatively high.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards. No problem exists in this basin with respect to these limits and standards.

D. Waste Load Effects on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such discharges affect water quality based upon the relationship between amount of discharge and amount of flow in the stream.

Also, as mentioned previously, the slope plays an important part in the ability of a stream to revive itself after being subject to organic waste loads. To determine the effects of waste loads on a stream a model has been developed in conjunction with the river basin planning effort and this model was used to determine the load effects on the streams. The Upper Cumberland Basin has a total of 752 miles of stream which carry effluent from treated organic loads. Of this total length, 176 miles are adversely affected by discharges, i.e., the dissolved oxygen level is predicted to be below 5 mg/l during period of low flow. It is interesting to note that of the 176 stream miles affected only 14 per cent of the length is affected by 90 per cent of total flow of the discharges. This 90 percent is composed of six (6) municipal discharges. The remaining discharges are small treatment plants scattered throughout the basin located on streams that normally possess zero flow during periods of most years.

E. Non-Point Source Effects

The topography of the area creates an inherent problem of erosion and sediment. Surface erosion is occurring on approximately 114 sq. mi. of rural areas, including surface mines, mine haul roads, logging roads and trails, log concentration yards, rural roads, streambanks, and utility rights-of way. This includes about 78 sq. mi. acres of inadequately treated croplands. Added to these figues are those sites in and around urban areas comprising approximately 9.5 sq. mi. that are being developed for residential, commercial, and industrial purposes.

Due to the growing urban areas of Middlesboro and Somerset runoff from these areas will increase the effect on the zero flow streams to which they are adjacent.

F. Water Uses

Of the many communities, industrial, and private users, three (3) withdraw over one million gallons per day. These are Middlesboro, Somerset and Corbin and they withdraw from surface waters for both industrial and public supply. The total basin withdrawal of all users is approximately 10,845,000 gallons per day of which 83 per cent is drawn from surface water and 70 per cent of the total is for public supply.

The Upper Cumberland Basin is a major area in the state with Lake Cumberland being the recreational main attraction, one of the large man-made lakes in the world. Also, Laurel River Lake and the portion of Dale Hollow Lake in Kentucky provide additional recreational facilities, as do the many smaller lakes in the area. This basin is considered one of the most important fishing areas of the state. Approximately 1,040 miles of stream are considered of fishery importance with some 440 miles affected by discharges.

G. Water Quality Changes

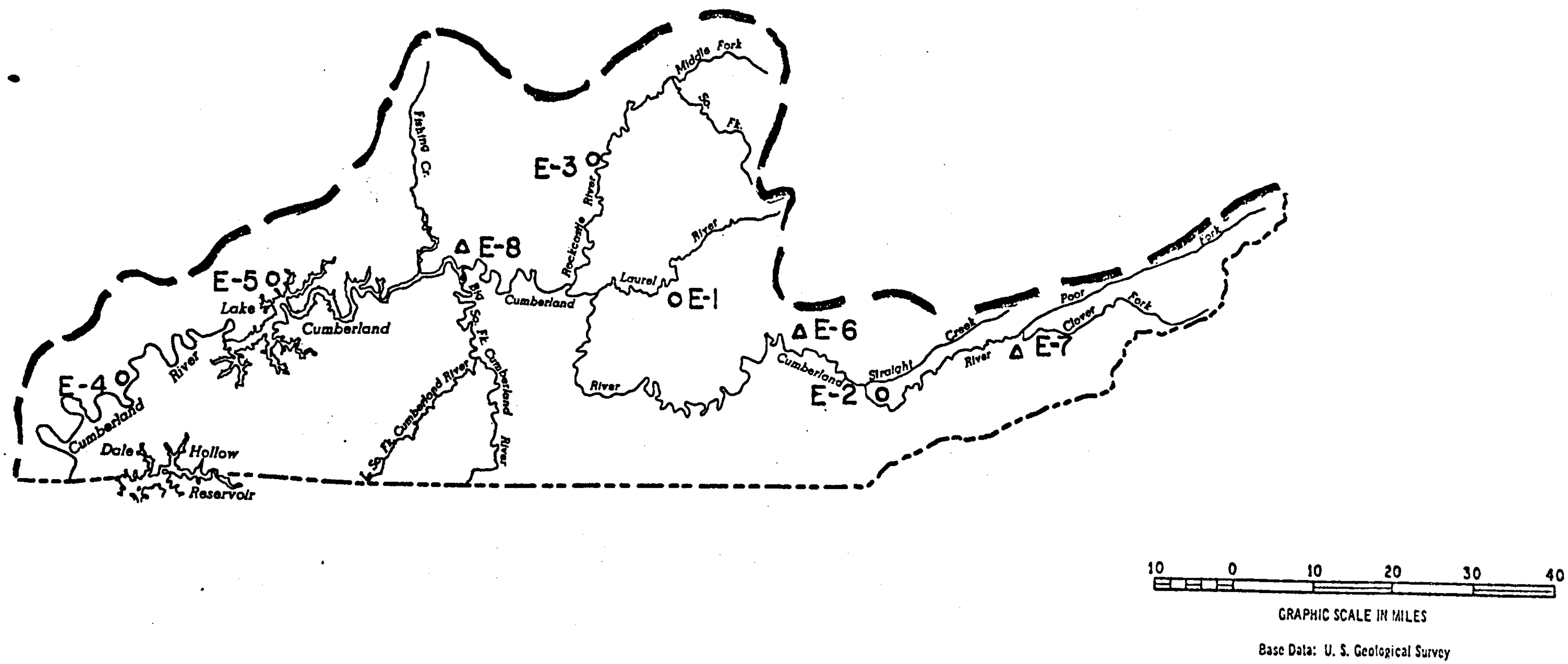
The water quality in the Upper Cumberland River Basin with the exception of that water quality in Yellow Creek and some of the tributaries above Harlan is excellent and low in mineralization and hardness. Any changes in water quality will be as a result of a marked increase in coal mining activities particularly in Harlan, Bell, Knott, and Whitley Counties. Waste from coal mining activities include acid mine drainage, however, the coal formations are not associated with high acid mine drainage production and sedimentation from surface disturbances particularly stripping and augering. The other effect on water quality where slight changes will occur is in the London-Corbin area where an ideal location for industrial development is expected to develop. The waste from this type of operation, however, is controllable and will not create major changes in the water quality of this area.

III. Water Quality Summary

Generally, it can be said the Upper Cumberland Basin is of good water quality. Nowhere along the main stem does the dissolved oxygen content fall below the minimum standard concentration of 5 mg/l. As discussed, the tributaries, due to the scattered discharges and low stream flows, are affected in regard to water quality. Improvements may be made either by improving treatment where appropriate or by improving operation. With the continuing technological improvements, better qualified operators are needed with better training and higher salaries to insure integrity in the sewage treatment plant's operation and maintenance.

The coal mining boom, due to the energy crisis and the abundance of coal as a fuel, may have a devastating effect on the water quality of this basin. Increased non-point source discharge due to the additional clearing of land will cause erosion and coal solids concentrations to be higher. Proper construction and drainage controls are needed to insure that under normal conditions coal solids are not discharged into the waters of the basin. More point source discharges in the form of preparation plants and coal washers will develop but should be kept in control by state issued operation permits and inspection as is done now. Cooperation is needed between all persons involved so that the Upper Cumberland River Basin will not only serve as a vital natural resource area, but will retain its recreational and environmental appeal.

UPPER CUMBERLAND RIVER



STATION KEY

E-1 LAUREL RIVER AT CORBIN
E-2 CUMBERLAND RIVER AT PINEVILLE
E-3 ROCKCASTLE RIVER AT BILLOWS
E-4 CUMBERLAND RIVER AT BURKESVILLE
E-5 CUMBERLAND RIVER AT ROWENA
E-6 CUMBERLAND RIVER AT BARBOURVILLE
E-7 CUMBERLAND RIVER AT HARLAN
E-8 LAKE CUMBERLAND AT SOMERSET

TABLE E-1

Sub-basins of 200 sq. mi. or Greater

Sub-basins	Square Miles
Clover Fork	222.0
Clear Fork	370.0
Laurel River	289.0
Rockcastle River	763.0
Bucky Creek	294.0
Clear Creek	283.0
South Fork Cumberland River	1,382.0
Beaver Creek	234.0
Total	3,837.0

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning Effort.

TABLE E-2

UPPER CUMBERLAND DRAINAGE AREA BY COUNTY

County	Total Area (sq. miles)	Area in Basin (sq. miles)	County	Total Area (sq. miles)	Area in Basin (sq. miles)
Adair	370	55	Letcher	339	50
Bell	370	355	Lincoln	340	80
Casey	435	44	McCreary	418	418
Clay	474	47	Metcalfe	296	45
Clinton	190	190	Monroe	334	110
Cumberland	310	310	Pulaski	653	653
Harlan	469	420	Rockcastle	311	251
Jackson	337	200	Russell	238	170
Knox	373	335	Wayne	440	440
Laurel	446	446	Whitley	458	458
			Total	7,601	5,077

SOURCE: Rand McNally Standard Reference Map and Guide of Kentucky, 1972.

TABLE E-3

Slopes and Elevations in Upper Cumberland River Basin

STREAM	LENGTH (Miles)	Max. El. (m.s.l.)	Min. El. (m.s.l.)	AVERAGE SLOPE (ft./miles)
Poor Fork Cumberland River	46.05	1,780	1,150	13.7
Yellow Creek	18.13	1,140	996	7.9
Clear Creek	4.82	1,194	985	43.4
Straight Creek	23.0	1,740	980	33.0
Clear Fork	18.6	938	896	2.3
Laurel Creek	10.31	1,340	955	37.3
Little Laurel River	19.3	1,160	1.030	6.7
Laurel River (above Lake)	30.05	1,200	982	7.3
Laurel River (below Lake)	2.3	767	737	13.0
Rockcastle River	69.2	1,015	723	4.2
Buck Creek	58.0	1,100	723	6.5
Pittman Creek	34.25	1,100	730	10.8
Cumberland River (above Lake)	190.8	2,049	723	6.95
Cumberland River (below Lake)	75.4	545	500	0.6

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning Effort.

TABLE E-5

MAJOR LAKES IN THE UPPER CUMBERLAND RIVER BASIN

Location	County	Surface Area (Acres)	Capacity Acre-Feet
Cranks Creek	Harlan County	219	6,400
Fern Lake	Bell County	101	902
Wood Creek Lake	Laurel County	672	23,270
Renfro Lake	Rockcastle County	274	4,404
Corbin Reservoir	Laurel, Knox, and Whitley Counties	139	2,500
Tyner Lake	Jackson County	87	2.364
Cannon Creek Dam	Bell County	243	11,300
	Total ----------------	1,735	51,140
Federal			
Laurel River Lake	Laurel and Whitley Counties	6,060	435,600
Lake Cumberland	Clinton, Russell, and Wayne Counties	63,530	6,089,000
Dale Hollow Lake	Cumberland and Clinton Counties	30,990	1,706,000
	Total ----------------	100,580	8,230,000
	Grand Total ----------------	102,315	8,281,140

SOURCE: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources.

TABLE E-6

Organic Loads Affecting Streams in the Upper Cumberland River

Length of streams to which treated organic loads are discharged		752
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		176
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	25
	Industrial Discharges	---
	Other Discharges	151

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicated the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year, seven day, low flow.

Table E - 7

City Population and Facility Grant Status in the Upper Cumberland River Basin in Kentucky

County	City	Population	Project Type	Comments
Adair				
Bell	Middlesboro	11,700	I	Underway
	Pineville	2,817	I	Pending
Casey				
Clay				
Clinton	Albany	1,891	I	Underway
Cumberland	Burkesville	1,717	I	Underway
Harlan	Harlan	3,200	I	Underway
	Loyal	1,212	I	Pending
	Evarts	1,182	I	Underway
	Cumberland-	3,624	I	Underway
	Benham	1,000		
	Lynch	1,700	I	Pending
Jackson	McKee	255	I	Underway
Knox	Barbourville	3,549	I	Underway
	Corbin	2,000		
Laurel	London-	4,337	I	Underway
	Corbin	582	I	Underway
Letcher				

Table E - 7
Continued

County	City	Population	Project Type	Comments
Lincoln	Crab Orchard	3,500	I	Underway
McCreary	Whitley City-Stearns	1,060	I	Underway
Metcalfe				
Monroe				
Pulaski	Somerset	10,500	I II	Underway Pending
	Burnside	586	I	Pending
Rockcastle	Mount Vernon	1,639	I	Underway
Russell	Jamestown-	1,027	I	Pending
	Russell Springs	1,641	I	Pending
Wayne	Monticello	3,618	None	Sewered
Whitley	Corbin	4,785		
	Williamsburg	3,687	I	Underway

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Quality.

Table E-8

Water Quality Data for the Upper Cumberland River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00400	pH Specific Units Kentucky Standard 6-LT-pH-LT-9						
Laurel R., Corbin	71/11/16	72/09/08	7.9	8.2	7.6	2	.424
U.S.G.S. 03405000	65/10/20	72/09/08	7.4	8.2	6.7	4	.648
Cumberland R. Pineville U.S.G.S. 03403000	60/05/03	72/09/07	7.6	7.9	7.3	4	.250
Rockcastle R., Billows	71/11/11	72/08/31	7.4	7.5	7.4	2	.071
U.S.G.S. 03406500	60/05/05	72/08/31	7.3	7.5	7.0	4	.222
Cumberland R., Burkesville	70/02/02	72/05/01	7.2	7.4	6.9	7	.227
U.S.G.S. 03414110	65/12/06	72/05/01	7.2	7.9	6.5	25	.353
STORET #00095	Conductivity Micromhos Kentucky Standard 800 micromhos						
Laurel R., Corbin	71/11/16	72/09/08	298.5	345.0	252.0	2	65.8
U.S.G.S. 03403000	65/10/20	72/09/08	294.0	401.0	178.0	4	98.8
Cumberland R., Pineville U.S.G.S. 03403000	60/05/03	72/09/07	382.3	495.0	294.0	4	91.3
Rockcastle R.,	75/06/13	75/09/02	184.0	223.0	145.0	2	55.2
Billows	71/11/11	72/08/31	211.5	214.0	209.0	2	3.6
U.S.G.S. 03406500	60/05/05	72/08/31	188.0	214.0	135.0	4	36.3
Cumberland R.,	70/02/02	72/05/01	141.8	174.0	110.0	8	21.1
Burkesville	65/12/06	72/05/01	148.9	203.0	110.0	28	17.9
STORET #70300	Dissolved Solids, milligrams per liter Ky. Std. 500 mgl						
Laurel R., Corbin	71/11/16	72/09/08	180.0	220.0	140.0	2	56.6
	71/11/16	72/09/08	180.0	220.0	140.0	2	56.6
Cumberland R., Pineville	60/05/03	72/09/07	230.0	316.0	180.0	3	74.8
Rockcastle R.,	75/06/13	75/09/02	102.5	119.0	86.0	2	23.3
Billows	71/11/11	72/08/31	130.5	132.5	129.0	2	2.1
	60/05/05	72/08/31	109.8	132.0	74.0	4	26.9

Table E-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Cumberland R., Burkesville	70/02/02	72/05/01	88.7	107.0	71.0	7	13.2
	65/12/06	72/05/01	90.5	117.0	70.0	25	11.8
STORET #00410	Alkalinity, mg/l, No Standard						
Laurel R., Corbin	71/11/16	72/09/08	62.0	75.0	49.0	2	18.4
	65/10/21	72/09/08	77.0	107.0	49.0	3	29.1
Cumberland R., Pineville	60/05/03	72/09/07	98.3	125.0	72.0	4	26.2
Rockcastle R., Billows	75/06/13	75/09/02	58.5	74.0	43.0	2	21.9
	71/11/11	72/08/31	76.5	78.0	75.0	4	2.1
	60/05/05	72/08/31	69.8	78.0	48.0	4	14.6
Cumberland R., Burkesville	70/02/02	72/05/02	40.9	62.0	31.0	7	10.6
	67/10/02	72/05/01	44.1	75.0	31.0	17	10.7
STORET #00900	Hardness, mg/l, 0-60 soft, 61-120 mod. hard, 120-180 hard, over 180 very hard						
Laurel R., Corbin	71/11/16	72/09/08	102.0	120.0	84.0	2	25.5
	65/10/20	72/09/08	85.5	120.0	42.0	4	32.6
Cumberland R., Pineville	60/05/03	72/09/07	96.7	130.0	74.0	4	23.7
Rockcastle R., Billows	75/06/13	75/09/02	83.0	100.0	66.0	2	24.0
	71/11/11	72/08/31	86.0	99.0	95.0	4	17.7
	60/05/05	72/08/31	86.0	99.0	60.0	4	17.7
Cumberland R., Rowena	65/05/20	65/05/20	54.0			1	
Cumberland R., Burkesville	70/02/02	72/05/01	59.3	70.0	54.0	7	6.0
	65/12/06	72/05/01	61.5	92.0	53.0	25	8.2
STORET #00080	Color, Platinum Cobalt Color Units, Proposed EPA Std. 75 units						
Laurel R., Corbin	65/10/20	65/10/21	17.5	25.0	10.0	2	10.6
Cumberland R., Pineville	60/05/03	60/05/03	5.0			1	
Rockcastle R., Billows	60/05/05	61/09/15	8.0	10.0	6.0	2	2.8

Table E-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Cumberland R., Rowena	65/05/20	65/05/20	6.0			1	
Cumberland R., Burkesville	70/02/02	70/02/02	5.0			1	
	67/10/02	70/02/02	3.3	5.0	0.0	3	2.9
STORET #00930	Sodium, mg/l No Standard						
Cumberland R., Pineville	60/05/03	60/05/03	32.0			1	
Rockcastle R., Billows	75/06/13	75/09/02	3.3	4.2	2.3	2	1.3
	66/12/02	70/02/02	2.2	2.7	1.7	2	.707
Cumberland R., Burkesville	70/02/02	70/02/02	5.6			1	
	66/12/02	70/02/02	5.1	5.6	4.8	4	.379
STORET #00935	Potassium, mg/l No Standard						
Cumberland R., Pineville	60/05/03	60/05/03	1.9			1	
Rockcastle R., Billows	75/06/13	75/09/02	2.4	2.8	2.0	2	.566
	60/05/05	61/09/15	1.0	1.6	0.4	2	.849
STORET #00940	Chloride, mg/l Proposed EPA Std. 25.0 mg/l						
Laurel R., Corbin	71/11/16	72/09/08	19.0	21.0	17.0	2	2.8
	65/10/20	72/09/08	22.3	34.0	17.0	4	8.1
Cumberland R., Pineville	60/05/03	72/09/07	11.7	20.0	4.0	4	6.7
Rockcastle R., Billows	75/06/13	75/09/02	4.3	6.0	2.5	2	2.5
	71/11/11	72/08/31	4.7	4.8	4.5	2	.212
	60/05/05	72/08/31	3.6	4.8	2.0	4	1.31
Cumberland R., Rowena	65/05/20	65/05/20	2.2			1	
Cumberland R., Burkesville	70/02/02	72/05/01	3.1	4.2	2.3	7	.716
	65/12/06	72/05/01	3.7	5.0	2.0	25	.754
STORET #00945	Sulfate, mg/l Proposed EPA Std. 250 mg/l						
Laurel R., Corbin	71/11/16	72/09/08	53.0	61.0	45.0	2	11.3
	65/10/20	72/09/08	38.8	61.0	15.0	4	19.3

Table E-8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Cumberland R., Pineville	60/05/03	72/09/07	76.5	96.0	68.0	4	13.1
Rockcastle R., Billows	75/06/13	75/09/02	23.0	27.0	19.0	2	5.7
	71/11/11	72/08/31	24.5	26.0	23.0	2	2.1
	60/05/05	72/08/31	20.8	26.0	17.0	4	4.5
Cumberland R., Rowena	65/05/20	65/05/20	21.0			1	
Cumberland R., Burkesville	70/02/02	72/05/01	27.4	36.0	23.0	7	4.3
	65/12/06	72/05/01	26.1	36.0	20.0	25	4.0
STORET #00618	Nitrate, mg/l Proposed EPA Std. 10 mg/l						
Laurel R., Corbin	71/11/16	72/09/08	1.45	1.9	1.0	2	.636
	71/11/16	72/09/08	1.45	1.9	1.0	2	.636
Cumberland R., Pineville	71/11/17	72/09/07	0.8	1.1	0.5	2	.424
Rockcastle R., Billows	75/06/13	75/09/02	.24	.42	.05	2	.262
	71/11/11	72/08/31	.25	.40	.10	2	.212
Cumberland R., Burkesville	72/05/01	72/05/01	0.6			1	
	72/05/01	72/05/01	0.6			1	
STORET #00950	Fluoride, mg/l Ky. Std. 1.0 mg/l						
Laurel R., Corbin	71/11/16	72/09/08	0.4	0.5	0.3	2	.141
	71/11/16	72/09/08	0.4	0.5	0.3	2	.141
Cumberland R., Pineville	60/05/03	75/09/07	.77	2.0	0.1	3	1.07
Rockcastle R., Billows	75/06/13	75/09/02	0.1	0.2	0.0	2	.141
	71/11/11	72/08/31	0.1	0.1	0.1	2	0.0
	60/05/05	72/08/31	0.15	0.3	0.1	4	0.1
Cumberland R., Burkesville	70/02/02	72/05/01	0.13	0.3	0.0	4	.126
	66/12/02	72/05/01	0.11	0.3	0.0	7	.107
STORET #00915	Calcium, mg/l No Standard						
Cumberland R., Pineville	60/05/03	60/05/03	17.0			1	

Table E- 8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Rockcastle R., Billows	75/06/13	75/09/02	25.5	31.0	20.0	2	7.8
	60/05/05	61/09/15	23.5	28.0	19.0	2	6.36
Cumberland R., Burkesville	70/02/02	70/02/02	21.0			1	
	66/12/02	70/02/02	18.8	21.0	16.0	4	2.2
STORET #00925	Magnesium, mg/l No Standard						
Cumberland R., Pineville	60/05/03	60/05/03	7.7			1	
Rockcastle R., Billows	75/06/13	75/09/02	4.85	5.7	4.0	2	1.2
	60/05/05	61/09/15	4.1	4.9	3.2	2	1.2
Cumberland R., Burkesville	70/02/02	70/02/02	4.2			1	
	66/12/02	70/02/02	4.6	5.4	4.2	4	.548
STORET #01025	Cadmium, micrograms per liter, Ky. Std. 100 ug/l						
Cumberland R., Barbourville	75.08/04	75/09/04	0.0	0.0	0.0	2	0.0
Rockcastle R., Billows	75/07/31	75/09/02	4.0	8.0	0.0	2	5.7
Cumberland R., Rowena	75/08/05	75/12/01	1.5	2.0	1.0	2	.707
	75/08/05	75/12/01	1.5	2.0	1.0	2	.707
STORET #01056	Manganese, ug/l. Proposed Ky. Std. 50 ug/l						
Cumberland R., Burkesville	72/05/01	72/05/01	13.0			1	
	72/05/01	72/05/01	13.0			1	
STORET #01046	Iron, ug/l Proposed EPA Std. 300 ug/l						
Cumberland R., Burkesville	72/05/01	72/05/01	50.0			1	
	72/05/01	72/05/01	50.0			1	
STORET #01030	Chromium, ug/l. Ky. Std. 50 ug/l						
Cumberland R., Barbourville	75/08/04	75/09/04	0.0	0.0	0.0	2	0.0

Table E- 8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Rockcastle R., Billows	75/07/31	75/09/02	2.5	5.0	0.0	2	0.0
Cumberland R., Rowena	75/08/05	75/12/01	5.0	10.0	0.0	2	7.1
	75/08/05	75/12/01	5.0	10.0	0.0	2	7.1
STORET #01049	Lead, ug/l, Ky. Std. 50 ug/l						
Cumberland R., Barbourville	75/08/04	75/09/04	0.0	0.0	0.0	2	0.0
Rockcastle R., Billows	75/07/31	75/09/02	38.5	70.0	7.0	2	44.5
Cumberland R., Rowena	75/08/05	75/12/01	7.0	8.0	6.0	2	1.41
	75/08/05	75/12/01	7.0	8.0	6.0	2	1.41
STORET #01000	Arsenic, ug/l, Ky. Std. 50 ug/l						
Cumberland R., Barbourville	75/08/04	75/09/04	0.5	1.0	0.0	2	.707
Rockcastle R., Billows	75/07/31	75/09/02	0.0	0.0	0.0	2	0.0
Cumberland R., Rowena	75/08/05	75/12/01	0.0	0.0	0.0	2	0.0
	75/08/05	75/12/01	0.0	0.0	0.0	2	0.0

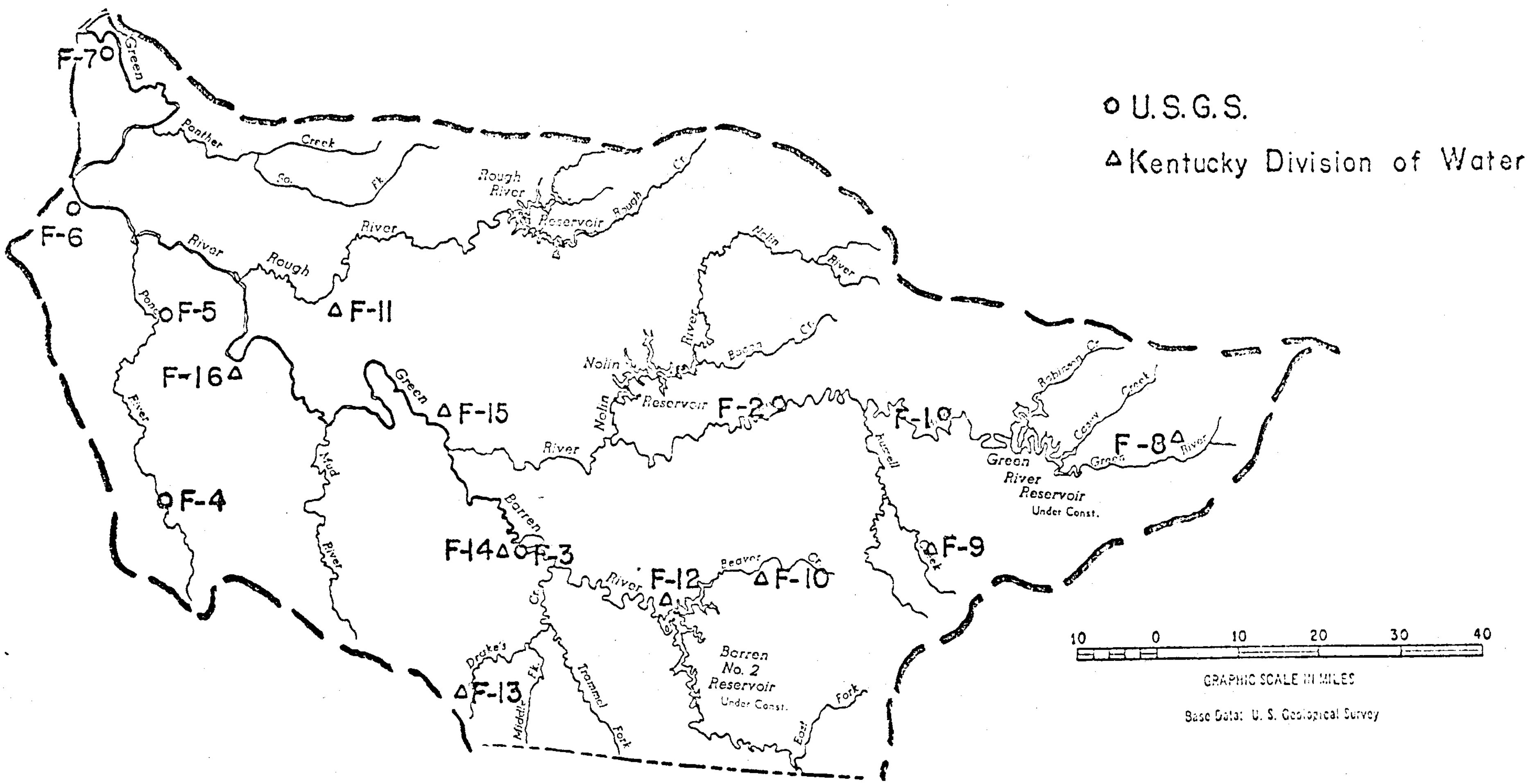
Bacteriological Data
Storet #31503 Total Coliform colonies per 100 ml. Ky. Std. 1000/100ml.
Storet #31616 Fecal Coliform colonies per 100 ml.

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS
Poor Fork, Cumberland R.						
T. Coli.	75/02/26	75/11/17	14,000	26,826	800	9
F. Coli.	75/02/12	75/10/30	9,965	59,000	20	7
Cumberland R., Harlan						
T. Coli.	75/02/13	75/11/11	12,968	38,000	1900	11
F. Coli.	75/02/13	75/07/31	693	1,200	300	6
Cumberland R., Pineville						
T. Coli.	75/02/15	75/11/11	5,909	31,000	1400	11
F. Coli.	75/02/13	75/07/28	635	1,700	160	6
Laurel R., Corbin						
T. Coli.	75/05/11	75/11/11	681	3,400	80	10
F. Coli.	75/02/11	75/05/22	90	300	0	4

Table E- 8
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Lake Cumberland, Somerset							
T. Coli.	75/01/06	75/12/04	159	745	0	14	
	74/03/25	75/12/04	118	745	0	28	
F. Coli.	74/10/07	75/02/18	50	156	0	8	
	75/01/06	75/02/18	58	140	3	4	

GREEN RIVER



o U.S.G.S.
△ Kentucky Division of Water
F-1
F-2
F-3
F-4
F-5
F-6
F-7
F-8
F-9
F-10
F-11
F-12
F-13
F-14
F-15
F-16
Green
Panther
Creek
Rough River Reservoir
Rough
River
Cr.
Nolin
River
Nolin Reservoir
Bacon
Cr.
Green
Mud
River
Pond
Barren
Beaver
Drake's
Middle Fk.
Trammel Fork
Barren No. 2 Reservoir
Under Const.
East Fork
Russell
Robinson Cr.
Casey Creek
Green River Reservoir
Under Const.
10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

THE GREEN RIVER BASIN

The Green River Basin is located in West Central Kentucky and Northern Tennessee. The first section of this report will deal with the general description of the area. The second section will enter into an analysis of the water quality in the basin, its causes and effects. The third section of the report summarizes the water quality of the basin and the correction needs.

I. A Description of the Green River Basin

A. Geography

The Green River Basin is located in West-Central Kentucky and in Northern Tennessee. It comprises a total drainage area of 9,229 sq. mi., with 8,821 in Kentucky and 408 in Tennessee. The Green River Basin encompasses all or portions of 31 counties in Kentucky and 3 in Tennessee. (The Kentucky County Areas are listed in Table F-1 of the Appendix). The Green River is a tributary of the Ohio River, the confluence of the Green River with the Ohio River is 197 miles above the mouth of the Ohio River. The main tributaries of the Green River are the Barren, Nolin, Pond and Rough Rivers. These and other sub-basins with drainage basin areas over 200 sq. mi. are listed in Table F-2 in the Appendix.

B. Topography

The primary interest is in the character and slopes of the land and the streams within the basin as they affect water quality. The slope of the land is one of the variables which contributes to water quality. The character indicates the type of land over which the runoff travels before entering the stream. The largest portion of the Green River Basin is in the physiographic region known as the Mississippian Plateau which can be characterized as gently rolling fields, rocky hillsides, and Karst topography. Karst topography has many sinkholes, underground solution channels and caves. Some wastewater treatment plants and storm water runoff are discharged in the underground formations since the region is without surface streams. The second largest physiographic region is the Western Kentucky Coal Fields with somewhat higher elevations and generally more rugged than the Mississippian Plateau Region. The Mississippian Plateau Region has a lower quantity of runoff and higher runoff quality than the Western Kentucky Coal Field Region.

The quality of the water in a stream can be influenced by the slope of the stream. This effect is demonstrated in the direct relationship between the slope and the capacity of the stream to assimulate waste loads through reaeration. A stream slope of 2 ft./mi. or less produces a low rate of reaeration. A stream slope between 2 and 6 ft./mi. produces a moderate rate of reaeration. Slopes between 6 and 10 ft./mi. produces a high rate of reaeration. The main stem of the Green River flows into the Ohio River at elevation 338 feet above mean sea level (m.s.l.) and is controlled by a series of six locks and dams for navigational purposes. These structures with mile points and pool lengths are listed in Table F-3. Past these structures the river then rises at a gradual slope of 1.6 ft./mi. to the Green River Reservoir at elevation 600 feet above m.s.l. The tributary slopes range from 0.8 ft./mi. to 3 ft./mi. in the lower reaches and 4.7 ft./mi. to 7.7 ft./mi. in the upper regions and the highest elevation is 1,040 feet above m.s.l. A complete list of slopes is included in Table F-2 of the Appendix.

C. Geology

Surface water quality in the Green River Basin is affected by the parent bedrock, mineral resources and groundwater. The base parent material for most of the Green River Basin is limestone bedrock which produces a bicarbonate type hardness in the water. The Pond River and Rough River sub-basins have sandstone and shale rock layers which produce a sulfate type hardness in the water.

The major mineral resources of the Green River Basin are coal, oil and gas with coal being the largest resource. Generally, coal production in this basin increases acidity and mineralization in the stream. Approximately 40 million tons of coal was produced in the basin in 1972, 94% of which was mined in 3 counties, Muhlenberg (65%), Ohio (16%) and Hopkins (13%). These and other county coal productions are listed in Table F-4 of the Appendix. Approximately 75% of the basin's production in 1972 was done by strip mining on 12.5 sq./mi. A "Soil Conservation Service" basin study indicates about 264 sq./mi. of strip mineable coal still exists. The Green River Basin contributed one-third of the total coal production in 1972, and it has been estimated that coal production in Kentucky by 1985 will reach 400 million tons per year, 3 1/3 times the 1972 figure. A copy of the Commonwealth of Kentucky strip mining slope regulations is included in Table F-5 of the Appendix.

Other mineral resources in the Green River Basin are oil and gas. Oil wells in Kentucky can produce a brine as a waste product. Disposal of brine water other than by reinjection could degrade water quality. In the Green River Basin oil and gas production are not expected to increase in the future.

An important groundwater effect on water quality is the increase in assimilative capacity of the stream due to the substantial amounts contributed to the base flow by springs in the Mississippian Plateau during period of low flow.

Groundwater yields in the Green River Basin range from 50 gallons per minute (g.p.m.) or less in 75 percent of the basin; 50-500 g.p.m. in approximately 24 percent of the basin,and 500 to 1,000 g.p.m. in approximately 1 percent of the basin. A map of these regions is included in the Appendix.

D. Hydrology

The stream flow of the Green River Basin was obtained at six stations: (1) Nolin River at Kyrock, (2) Barren River at Bowling Green, (3) Rough River at the Falls of the Rough River, on the main stem of the Green River at (4) Munfordsville, (5) Lock Number 4 and (6) Lock Number 2. The low flows at all of these stations were augmented by Corps of Engineer Reservoirs. The low flow period for once in 10 years for 7-days is adjusted to include flow augmentation provided by the impoundments. The yields without augmentation are low and a large drainage basin area is needed before a flow occurs. In the Barren River Basin 100 sq. mi. of drainage area will be needed for 2 cubic feet per second/ square mile (c.f.s./sq.mi.) of low flow. Because of this flow condition water quality becomes increasingly difficult to maintain during periods of low flow.

The Karst topography (see Topography) has an influence on the hydrology of the Green River Basin. The sinkholes and underground solution channels store the runoff water during periods of high flows, and discharge this stored water through springs after the peak flow in the stream system has passed.

In addition to the streams mentioned there are 13 major lakes located within the basin, (Table F-7 of the Appendix). Nine of these are multiple purpose structures, two slurry dams for Peabody Coal Company, one flood retard- ent structure and one for recreation purposes. There are 4 Corps of Engineers Reservoirs with a total area of 29,090 acres at seasonal pool with a total volume of 532,000 acre feet. They are the Nolin River, Green River, Barren River, and Rough River reservoirs. They are all designed and operated for flood control, recreation, low flow augmentation and fish and wildlife purposes, and in addition the Green, Barren and Rough River Reservoirs have volume allocated for water supply. Lakes by the U.S.D.A. Soil Conservation Service and others have 32,200 acre feet of volume. These lakes have no volume allocated or discharge structure needed for low flow augmentation.

E. Population

The total population in the basin is 426,000 which is distributed uniformly except for major population centers located in Warren (Bowling Green; 36,400), Hardin (Elizabethtown; 11,700), Barren (Glasgow; 11,300), Hopkins (Madisonville; 15,300), and Muhlenberg (Greenville-Central City; 9,330) counties. Of these major cities Madisonville, Elizabethtown and Glasgow discharge to zero flow streams and have a measurable impact on water quality. Populations of the other basin counties are listed in Table F-8 of the Appendix with the municipalities listed in Table F-9 of the Appendix. The basin population is 35 percent urban and 65 percent rural.

TABLE F-13

SURFACE WATER RECORDS FOR THE GREEN RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Nolin River at Kyrock [1]	27 yr.	703 sq.mi.	887 cfs, 1.3cfs*/sq.mi.	22,700 cfs, 32cfs/sq.mi.	0 cfs	50 cfs
	wtr/yr 1975		1,327 cfs, 1.9cfs/sq.mi.	8,340 cfs, 12cfs/sq.mi.	0 cfs	
Barren River at Bowling Green [2]	37 yr.	1,848 sq.mi.	2,520 cfs, 1.4cfs/sq.mi.	85,000 cfs, 46cfs/sq.mi.	44 cfs, 0.0cfs/sq.mi.	116 cfs
	wtr/yr 1975		3,975 cfs, 2.2cfs/sq.mi.	57,500 cfs, 31cfs/sq.mi.	227 cfs, 0.1cfs/sq.mi.	
Rough River at Falls of Rough [3]	27 yr.	504 sq.mi.	741 cfs, 1.5cfs/sq.mi.	12,400 cfs, 25cfs/sq.mi.	6 cfs, 0.0cfs/sq.mi.	50 cfs
	wtr/yr 1975		983 cfs, 2.0cfs/sq.mi.	3,490 cfs, 7cfs/sq.mi.	27 cfs, 0.1cfs/sq.mi.	
Green River at Munfordville [4]	49 yr.	1,673 sq.mi.	2,648 cfs, 1.6cfs/sq.mi.	76,800 cfs, 46cfs/sq.mi.	39 cfs, 0.0cfs/sq.mi.	152.4 cfs
	wtr/yr 1975		3,778 cfs, 2.3cfs/sq.mi.	48,300 cfs, 29cfs/sq.mi.	238 cfs, 0.1cfs/sq.mi.	

TABLE F-13
Continued

STATION		PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Lock No. 4 at Woodbury	5	38 yr.	5,403 sq.mi.	8,071 cfs, 1.5cfs/sq.mi.	205,000 cfs, 38cfs/sq.mi.	200 cfs, 0.0cfs/sq.mi.	319.9 cfs
		wtr/yr 1975		12,560 cfs, 2.3cfs/sq.mi.	85,300 cfs, 16cfs/sq.mi.	728 cfs, 0.1cfs/sq.mi.	
Lock No. 2 at Calhoun	6	45 yr.	7,564 sq.mi.	10,920 cfs, 1.4cfs/sq.mi.	208,000 cfs, 27cfs/sq.mi.	280 cfs, 0.0cfs/sq.mi.	319.9 cfs
		wtr/yr 1975		15,490 cfs, 2.0cfs/sq.mi.	58,300 cfs, 8cfs/sq.mi.	742 cfs, 0.1cfs/sq.mi.	

* Cubic feet per second

1. Flow regulated since March, 1963 by Nolin Lake.
2. Flow regulated since March, 1964 by Barren River Lake.
3. Flow regulated since October, 1959 by Rough River Lake.
4. Flow regulated since February, 1969 by Green River Lake
5. Flow regulated by upstream lakes on Green, Barren, and Nolin River.
6. Flow regulated by upstream lakes on Green, Barren, Nolin, and Rough River.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

A. Description of Sampling Stations

The recorded water quality of the basin is presented along with some of the major causes and effects. Also presented are the major uses of surface water in the basin description of the water sampling stations.

There were four stations used in this report to describe the typical water quality within the basin. The first station is on the main stem of the Green River at Munfordville covering 1,673 square miles (sq. mi.) or 18% of the Green River Basin. The second station is located at Bowling Green covering 1,848 sq. mi. or 82% of the Barren River Sub-basin. The third station is on the Green River approximately mid-river at Central City with 6,300 sq. mi. or 68% of the basin area above the station. The fourth station is on the main stem of the Green River near its mouth at Lock No. 1 covering 9,181 sq. mi. or 99% of the basin.

The Pond River near Sacramento was chosen to describe the effect of coal production on water quality in the Green River Basin. This station is located in the heart of the coal production of Western Kentucky, also some oil production occurs. The drainage area at the station is 523 sq. mi. or 65% of the Pond River Sub-basin. The following discussion of parameters is based upon the data included in Table F-10 of the Appendix.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts. The influence of mining activities is clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20 - 25 parts per million as an average value.

The four reporting stations for general water quality reflect different situations on the river.

The Munfordville Station is near the headwaters but below the Green River Reservoir with 18% of the drainage area of the basin. This station has wide fluctuations between average and maximum value (Figure F-5). This station shows water quality in excess of those for Kentucky water particularly the high levels of sodium-(potassium) and chlorides. This can be attributed to an oil boom in Green and Taylor Counties which produced 10 million barrels in 1959. However, the graph for last year's data (Figure F-4) indicates these levels have decreased to pre-oil field conditions due to the decrease in oil production and an increase in control measures.

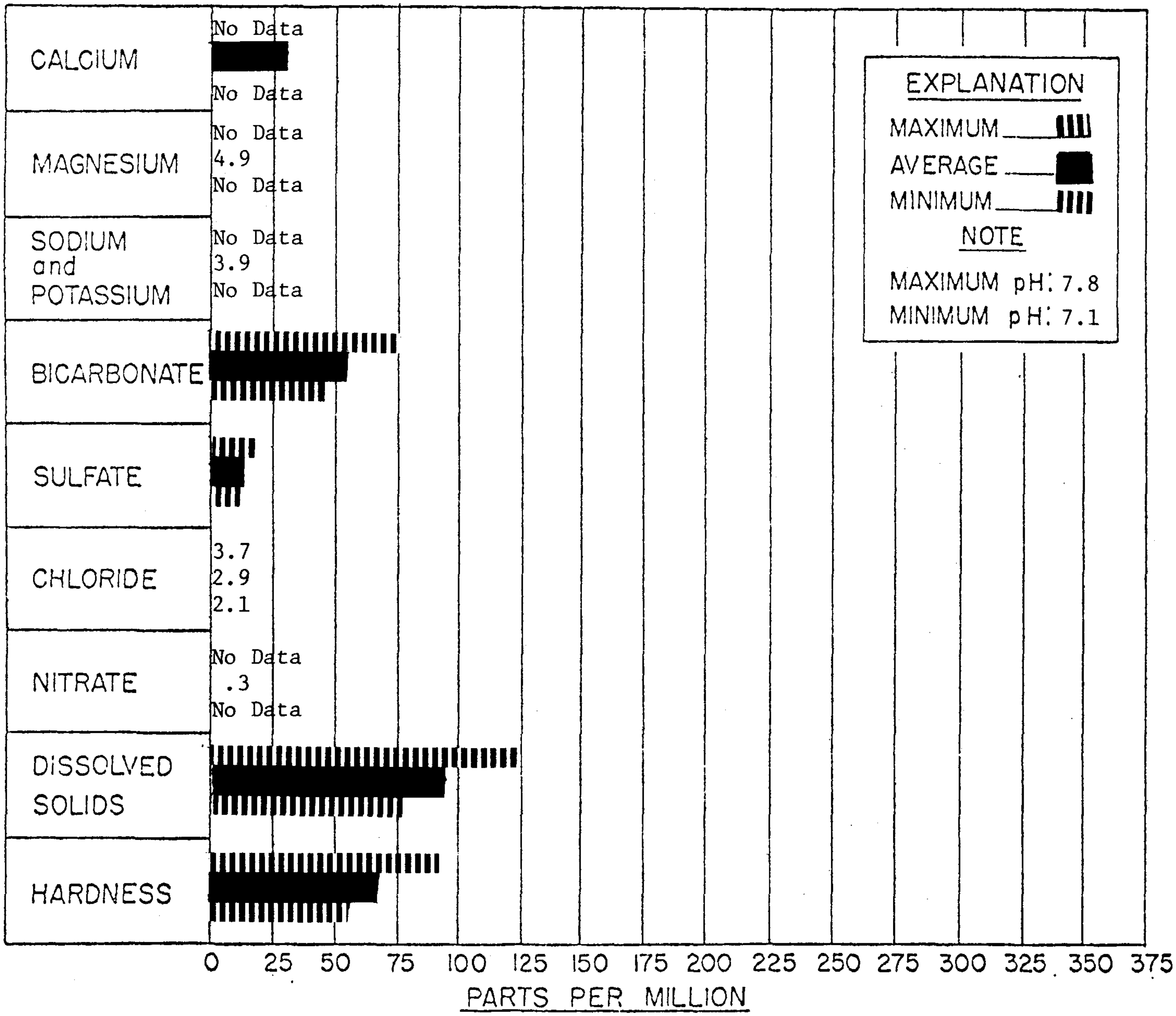
The station on the Barren River at Bowling Green has approximately the same size drainage basin area as the station at Munfordville but the station at Bowling Green shows a stable water quality which is attributed to the Barren

River Reservoir. The graph (Figure F-2) indicates that the natural water quality of the Barren River Basin is a bicarbonate type water with most mineralization (dissolved solids) in the form of calcium bicarbonate.

The Pond River at Sacramento was chosen to depict the influence of coal production on a small drainage basin. Every paramenter except bicarbonate (Figure F-7) is high in the Pond River which demonstrates the effect of acid mine drainage on water quality. Bicarbonate is a measure of a stream's capacity to neutralize acids. Bicargonate has been depleted by acid mine drainage and this effect is shown by an average pH value of 4.9 with a minimum value of 2.8. To meet the energy crisis coal production is expected to increase over three times the present rate in Kentucky. The effects of coal mining on the Pond River water quality emphasized the influence that a marked increase in coal mining in the Green River Basin can produce on the basin water quality.

The effect of energy related resource development is indicated by comparison (Figure F-8) of the Green River Station at Beech Grove (covering 99% of the basin) with the Barren River Station (Figure F-2). The decrease in dominance of the bicarbonate hardness over the sulfate hardness clearly illustrates the increasing influence of coal production on the Green River Basin. The relatively high levels of sodium-(potassium) and chlorides reflect the past influence of the oil production throughout the basin.

At this time, the chemical water quality in the Green River Basin is good, but the demand for coal could have disasterous and long lasting effects on the water quality in the portions of the Green River Basin downstream from these developments. The influence of coal production is long lasting because there is no effective means, known at this time, of treating or elimating acid mine drainage on a large scale.



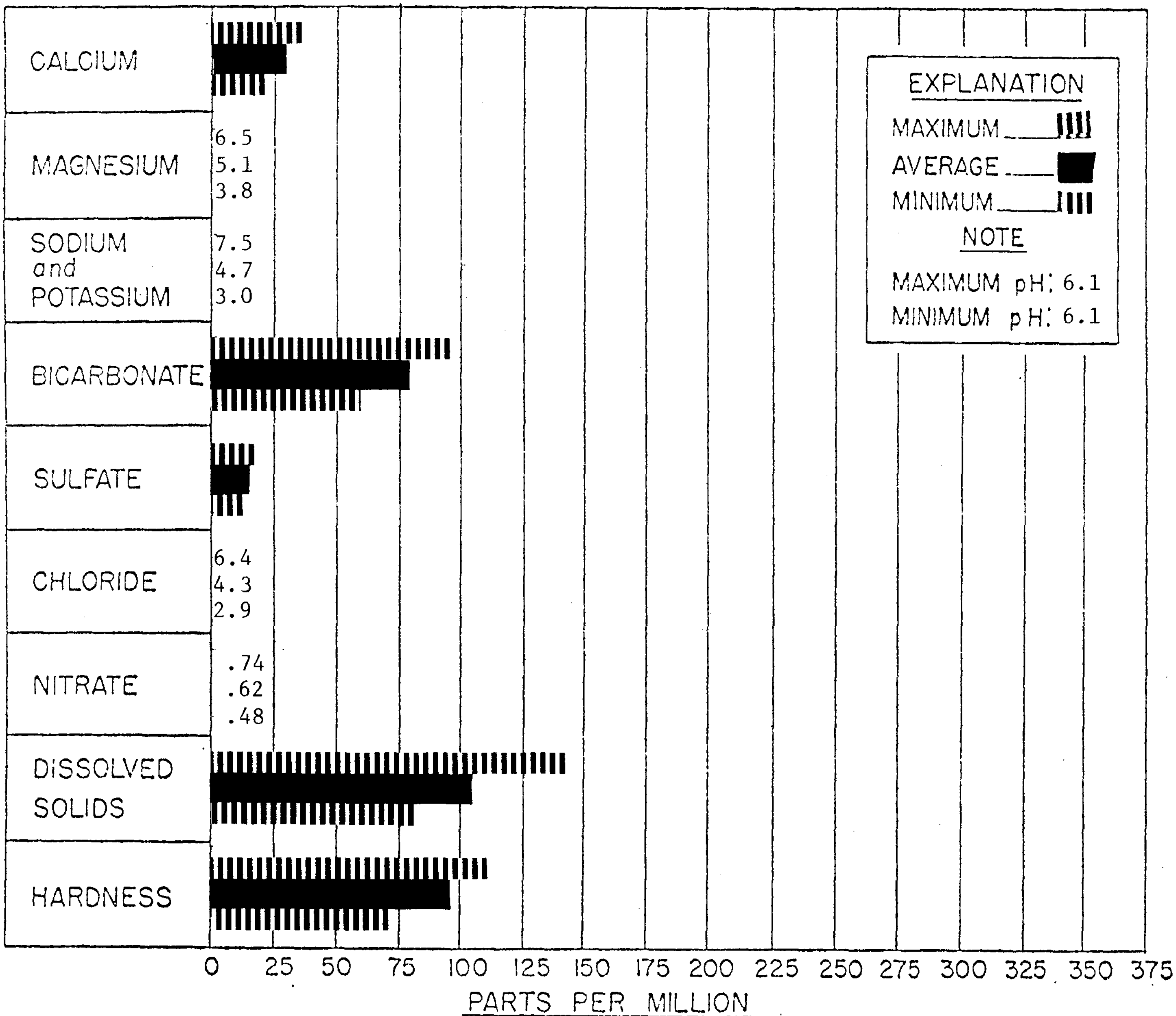
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE F-1

Green River

Greensburg

3-70 to 8-72



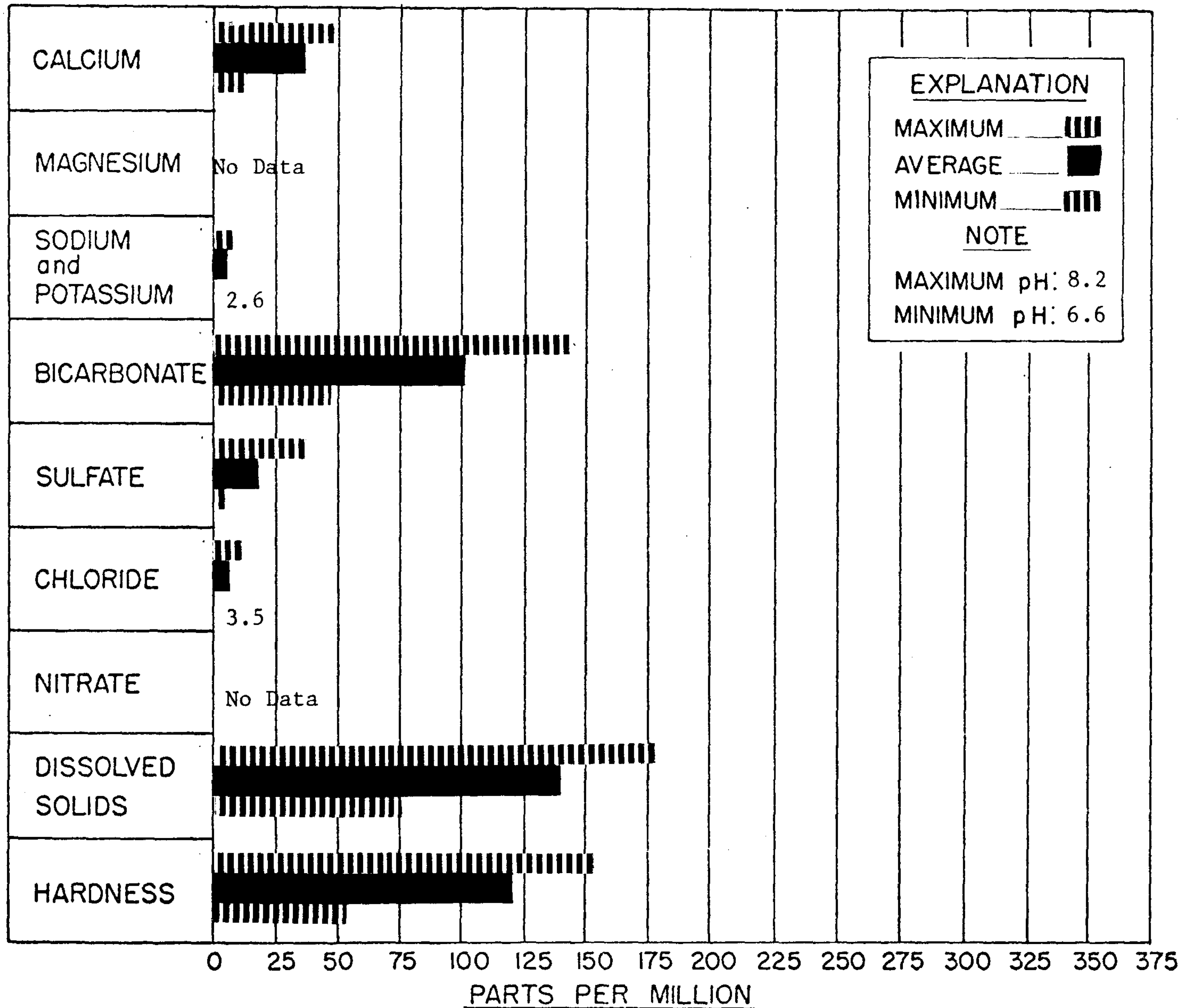
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE F-2

Barren River

Bowling Green

4-75 to 11-75



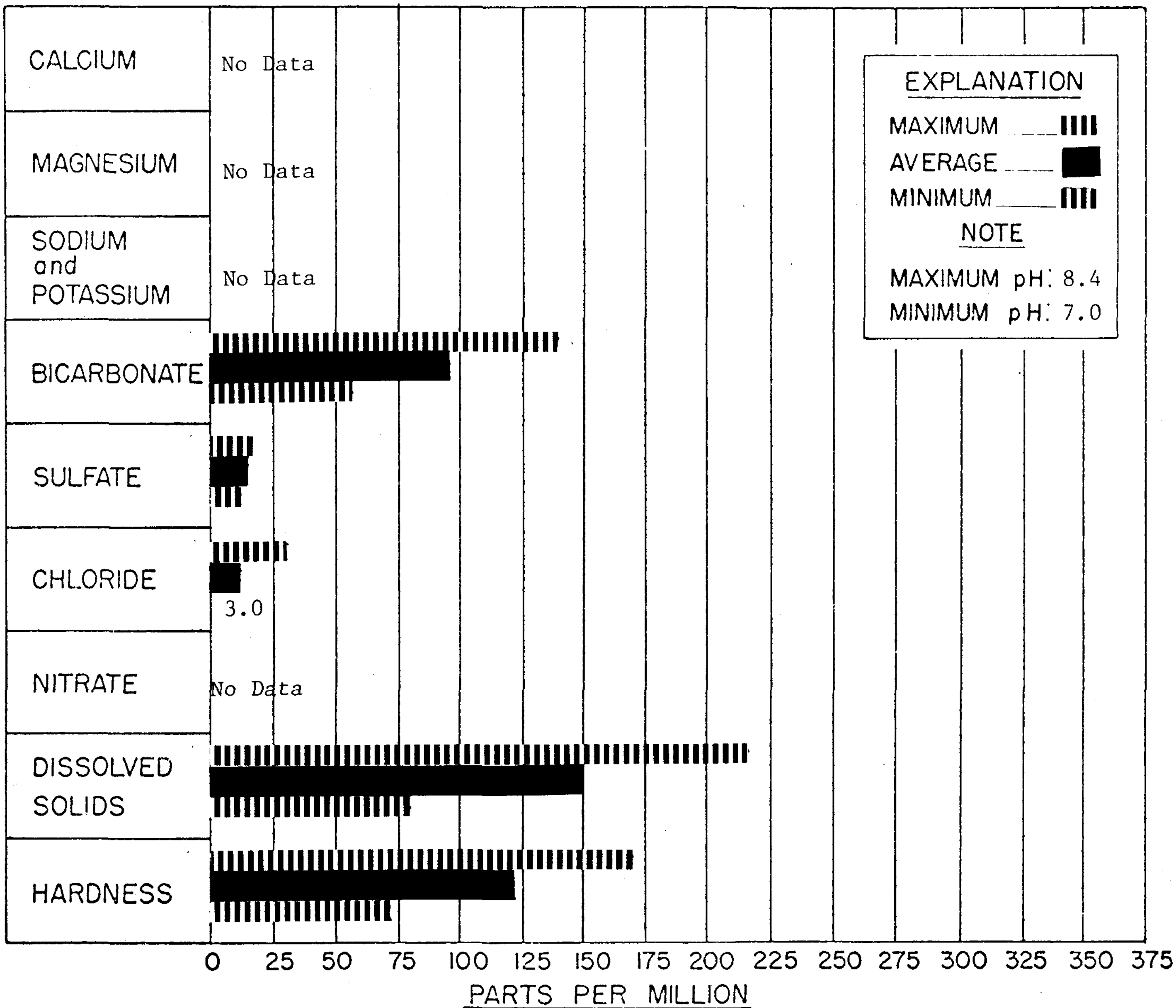
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE F-3

Barren River

Bowling Green

10-59 to 4-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE F-4

Green River

Munfordville

1-73 to 9-73

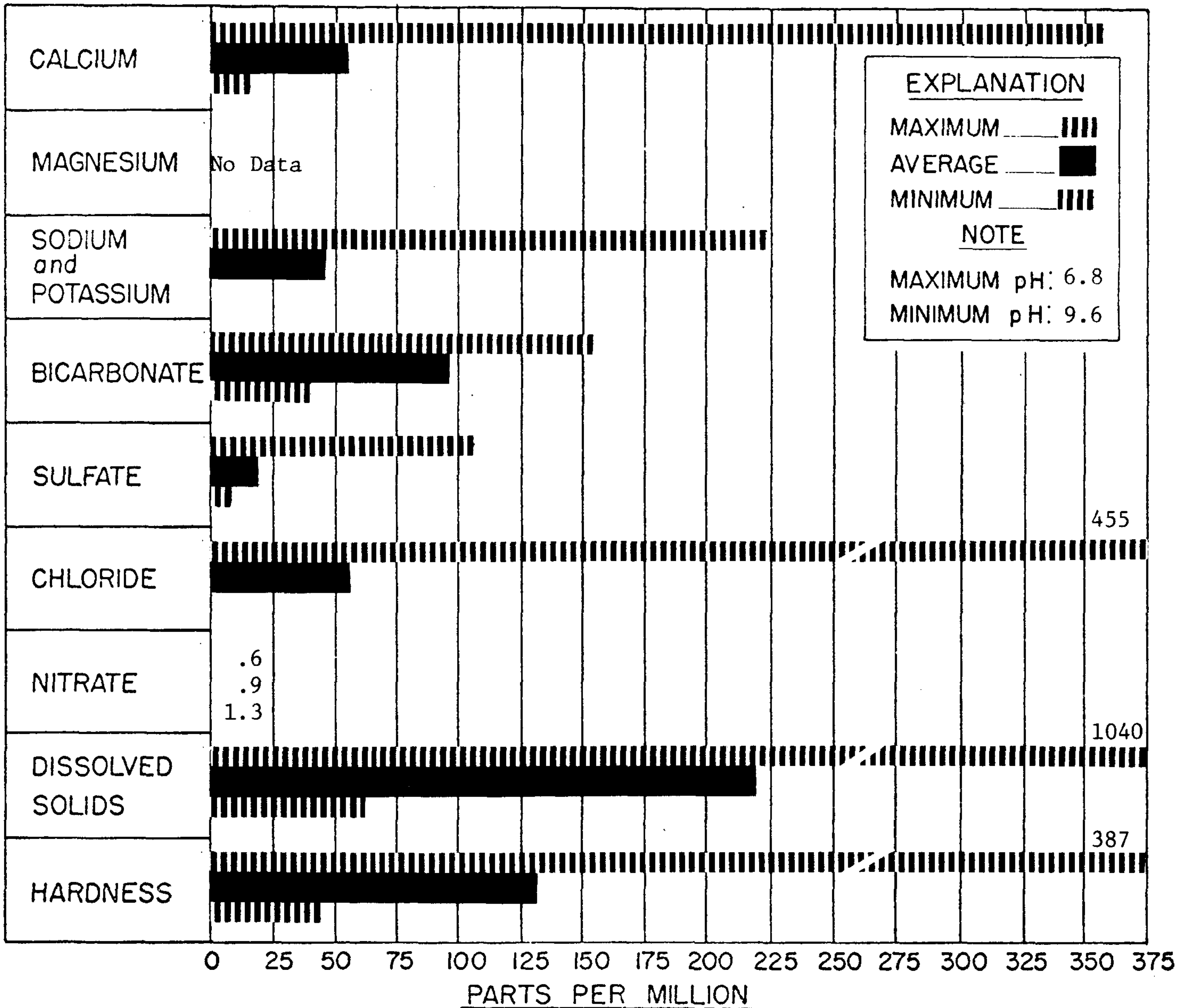


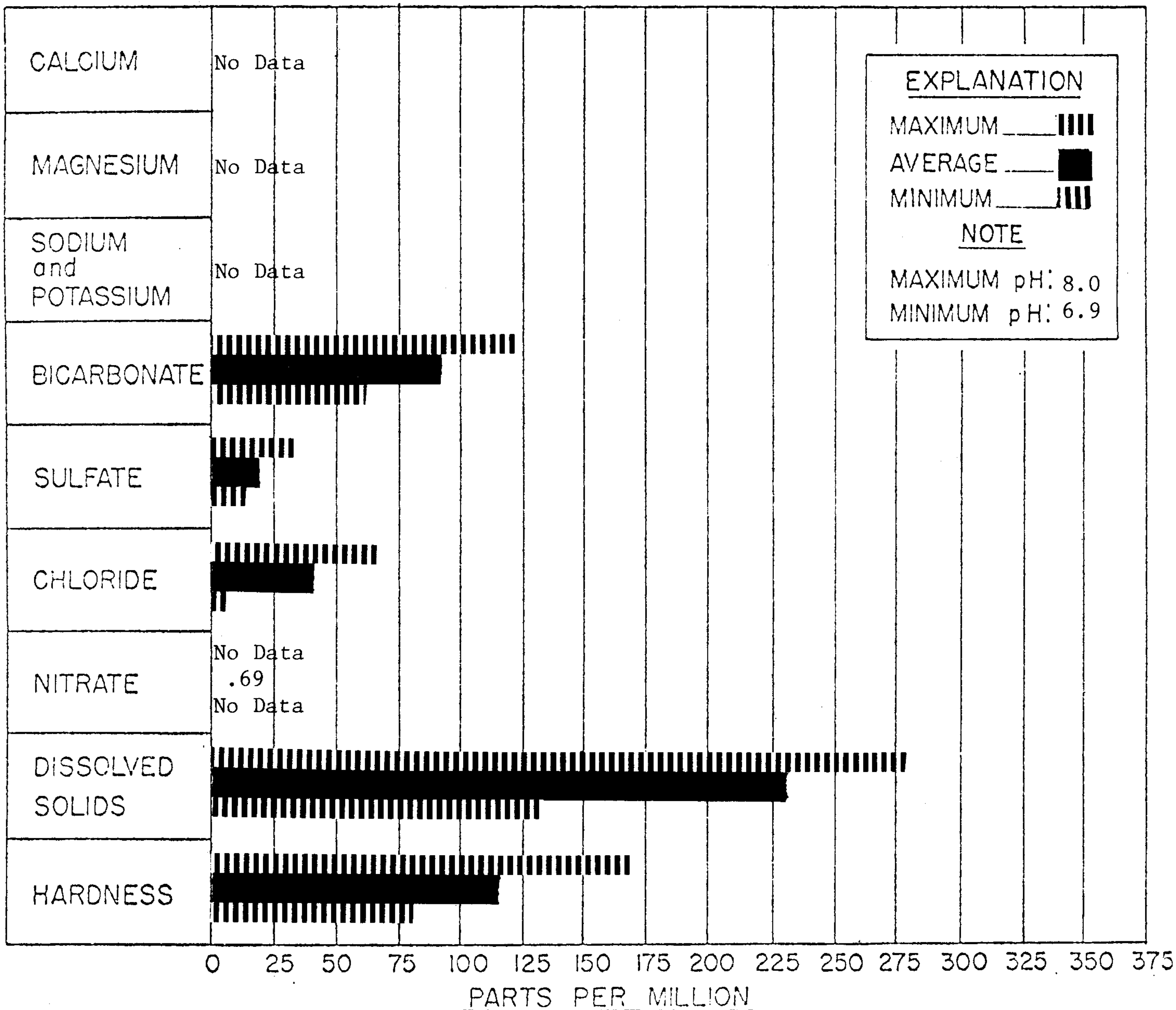
FIGURE F-5

Green River

Munfordville

1-61 to 9-73

MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,



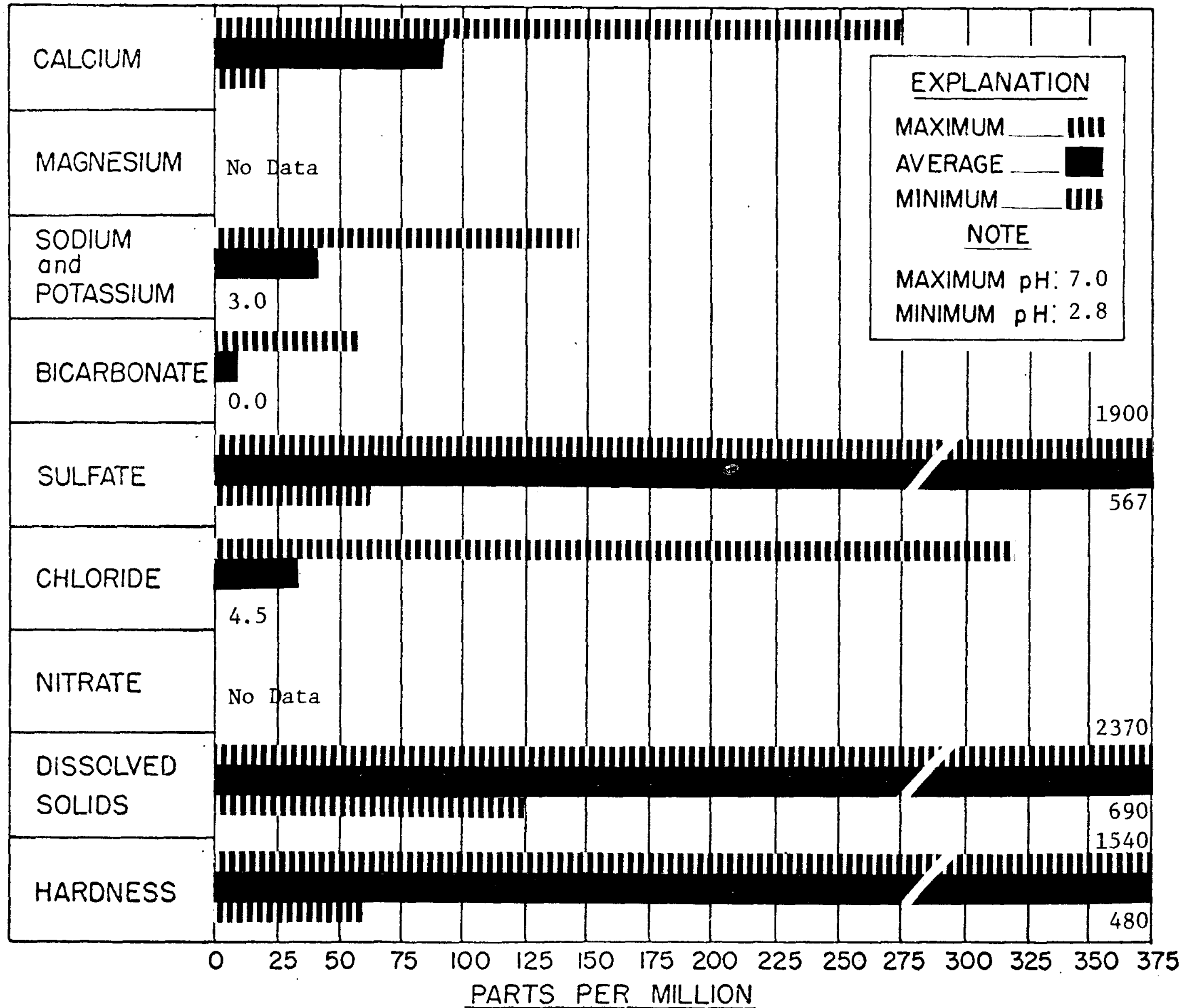
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE F-6

Pond River

Apex

4-61 to 8-72



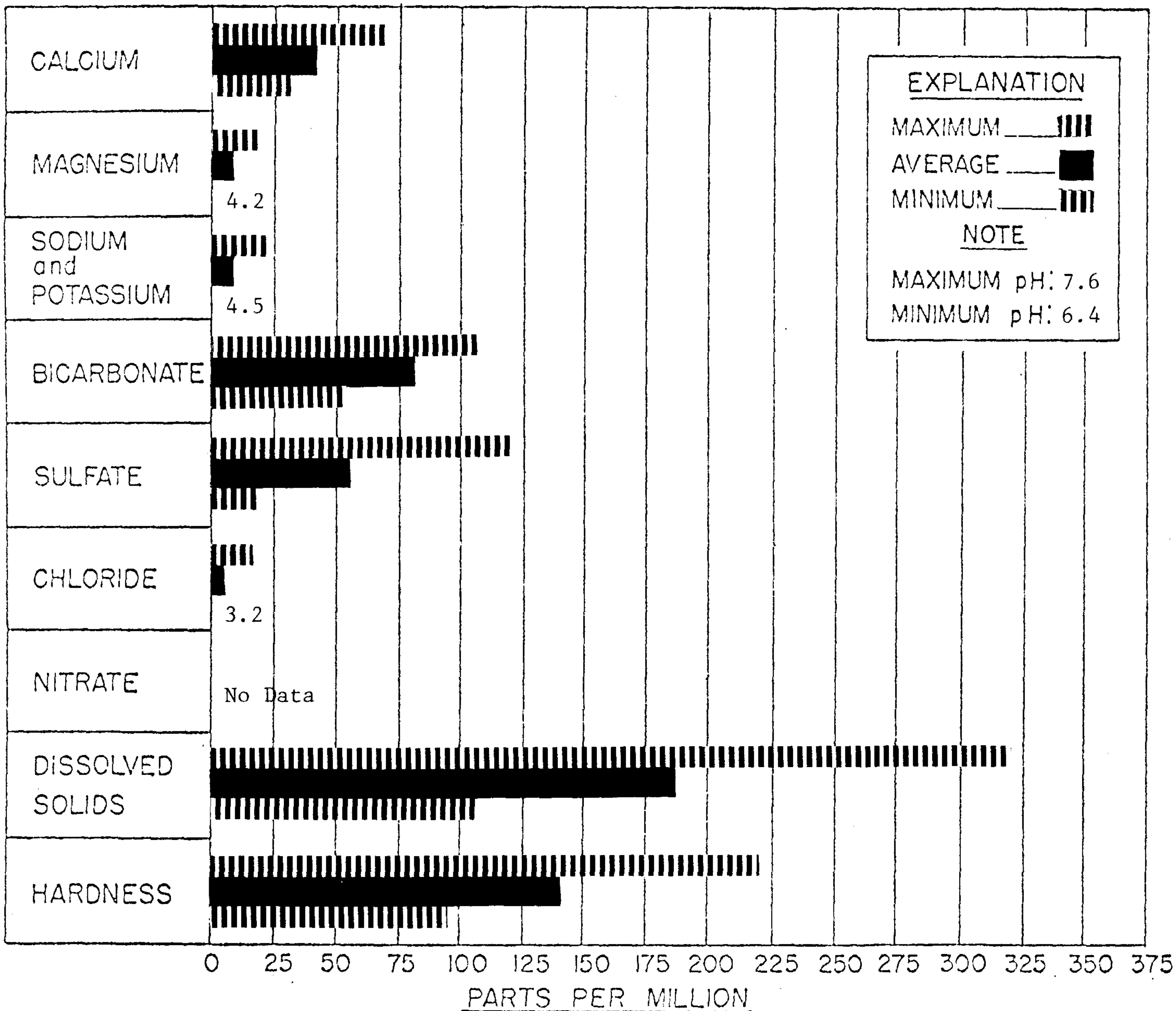
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE F-7

Pond River

Sacremento

10-59 to 6-73



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE F-8

Green River

Beech Grove

1-75 to 12-75

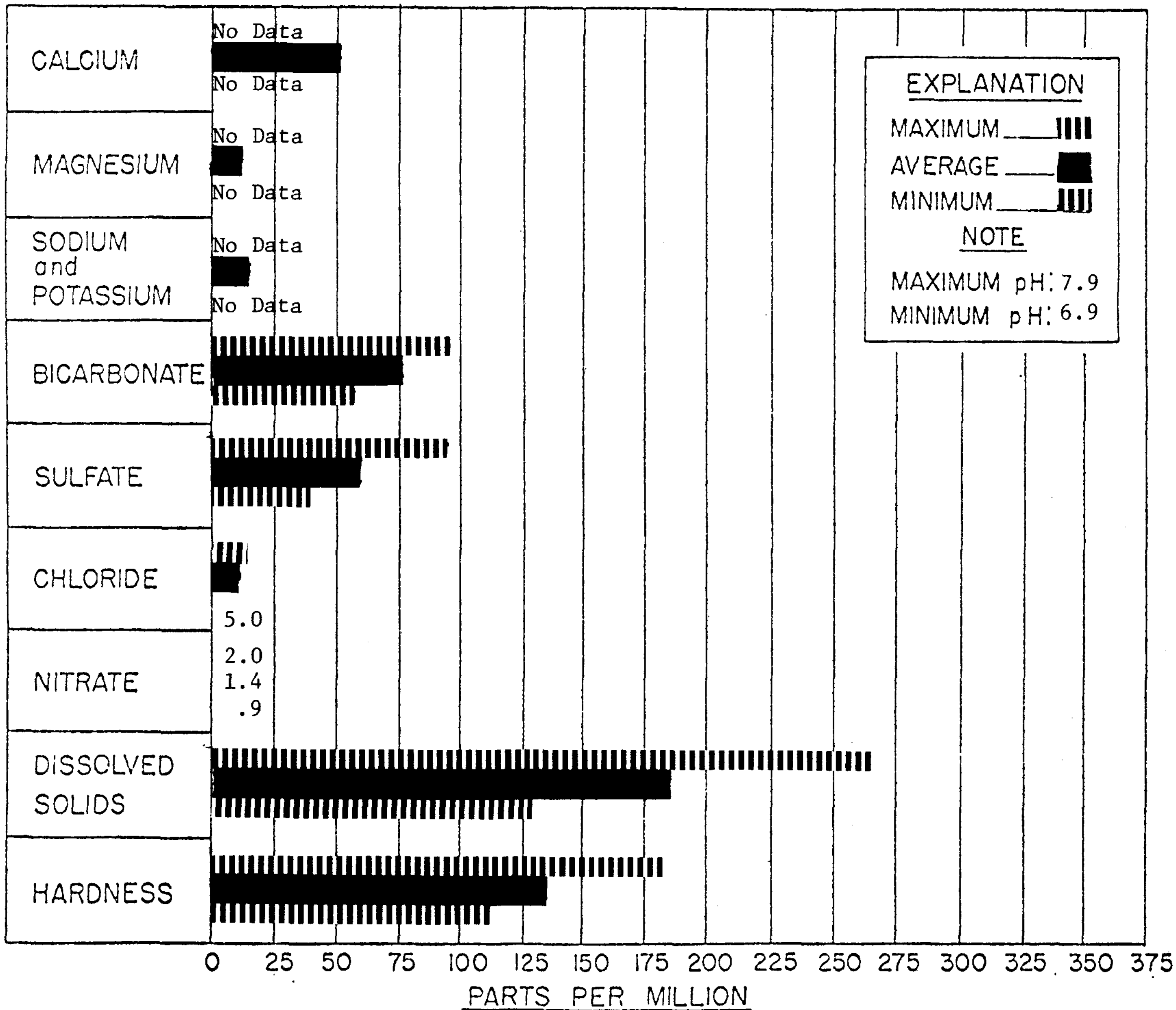


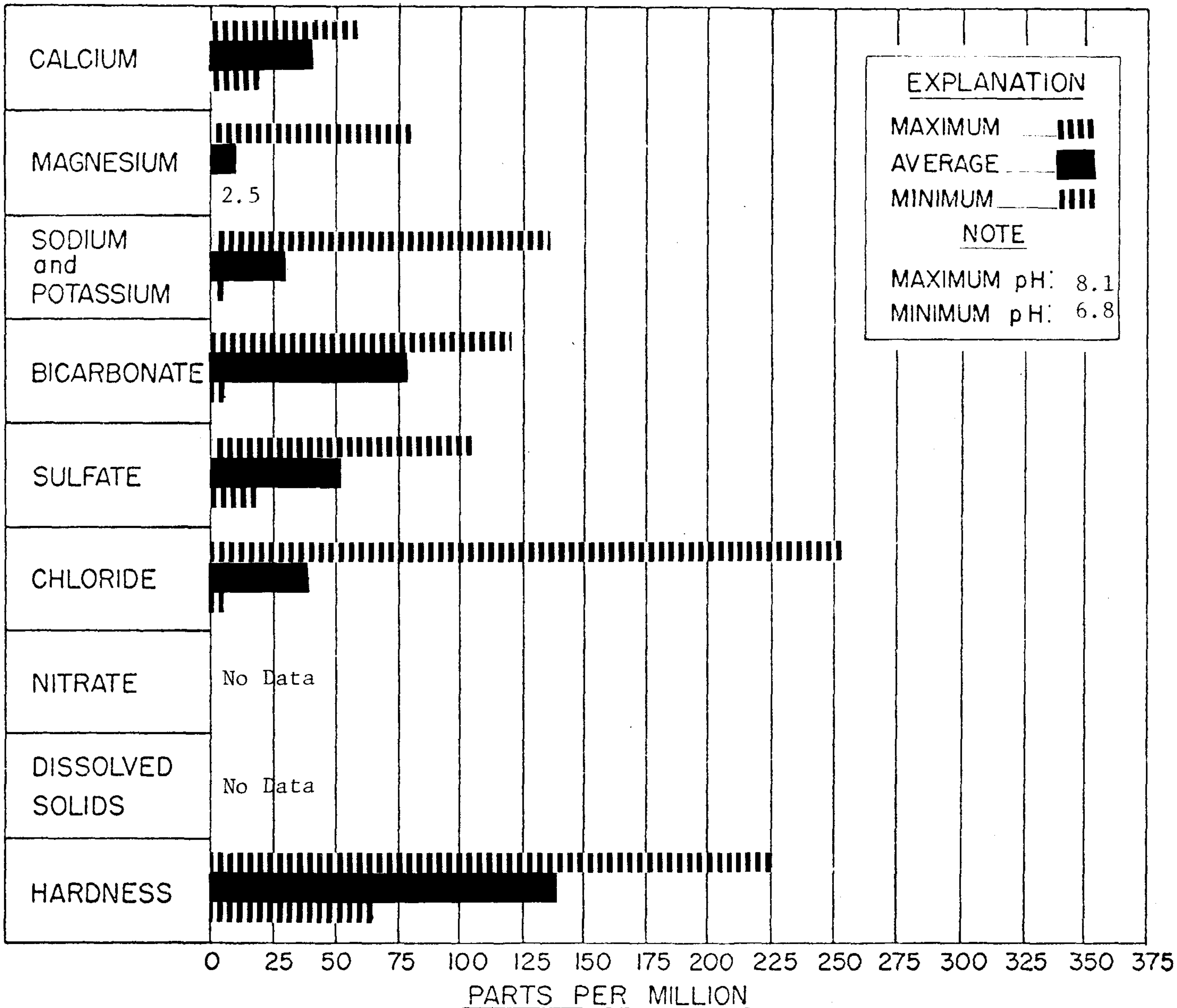
FIGURE F-9

Green River

Lock 1

4-70 to 8-72

MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE F-10

Green River

Lock No. 1

10-59 to 8-72

C. Trace Chemical Water Quality

Trace elements under 5.0 mg/l are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

As a part of the monitoring strategy for Kentucky "Special Surveys" will be undertaken to determine the causes of these levels.

D. Waste Load Affect on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such waste loads are considered to have an adverse effect on water quality when they cause the dissolved oxygen (D.O.) concentration of the water to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Approximately 1,670 miles of stream length were studied using a model to determine waste load allocation. The model was developed for the Kentucky Continuing Planning Process for River Basin Management Planning. Using this model it was determined that approximately 214 miles (12.8 percent) of the studied length would have a D.O. concentration of less than 5.0 mg/l. The design flow is equal to the ten year seven day low flow for this study, zero in many of the tributaries.

There were 214 miles of stream length affected, of which 172 miles (10.3 percent) will be affected by municipal discharges, 7 miles (0.4 percent) are affected by industrial discharges and 34 miles (2.1 percent) are affected by other discharges such as schools, trailer parks, subdivision, etc. These results are listed in Table F-11 in the Appendix.

E. Non-Point Source Effects

The major non-point sources in the Green River Basin are acid mine drainage, siltation, agricultural runoff, and storm drainage from large cities located near low flow streams. The acid mine drainage and much of the siltation is caused by the coal production which is located primarily in Muhlenberg, Hopkins and Ohio Counties. Small receiving streams affected by acid mine drainage cannot support permanent fish life, and water quality is deteriorated by major increases in hardness (calcium sulfate). A map showing the streams constantly affected by mining is included in the Appendix. Oil production (ten million barrels per year) in Kentucky results in some brine waste, the influence on water quality in the Green River Basin is revealed from the Water Quality graphs.

A Soil Conservation Service report indicates 18 million tons of sediment from erosion is entering the Green River stream system annually.

1. 53 percent of the sediment is produced by erosion from the basin's cropland.
2. 25 percent of the sediment is produced by gully erosion.
3. 12 percent of the sediment is produced by erosion from disturbed forest lands.
4. 10 percent of the sediment is produced from erosion on previously surface mined lands, newly disturbed surface mined lands, 1,600 miles of roadbank erosion and 600 miles of streambank erosion.

Siltation impact has been reduced by silt retaining structures, diversion ditches and terraces, but this phenomena will represent a significant problem until quick vegetative cover and good soil conservation practices are universally applied.

Storm water runoff from large cities could represent a significant non-point source where this runoff enters a stream with a small dilution ratio. The cities in the basin in this category are Glasgow, Elizabethtown and Madisonville.

F. Water Uses in the Basin

Water uses in the basin are public, industrial, recreational, fish and wildlife and agricultural.

Public water use consists of 18.6 million gallons per day, 14.7 million gallons per day of which is from surface water sources and 3.7 million gallons per day is from groundwater sources.

Industrial water usage consists of 10.5 million gallons per day, 9.8 million gallons per day which is from surface sources and 776,000 gallons per day is from groundwater sources. A complete table for public and industrial water usage (Table F-12) is included in the Appendix.

Approximately 96,000 acres of land and 35,000 acres of water are used for recreational purposes in the area. Four Corps of Engineers' developments account for 29,000 acres of water and 34,000 acres of adjacent land. In 1969, the attendance at the four reservoir areas was nearly 2.9 million visitor days, the Rough River had 1,162,500 visitor days, the Nolin River had 345,500, the Barren River had 875,200, and the Green River had 509,400 visitor days.

Other recreational opportunities exist on 2,600 acres of water in completed PL 566 United States Department of Agriculture, Soil Conservation Service watershed developments and about 3,400 acres of water in State, County, City and privately owned developments.

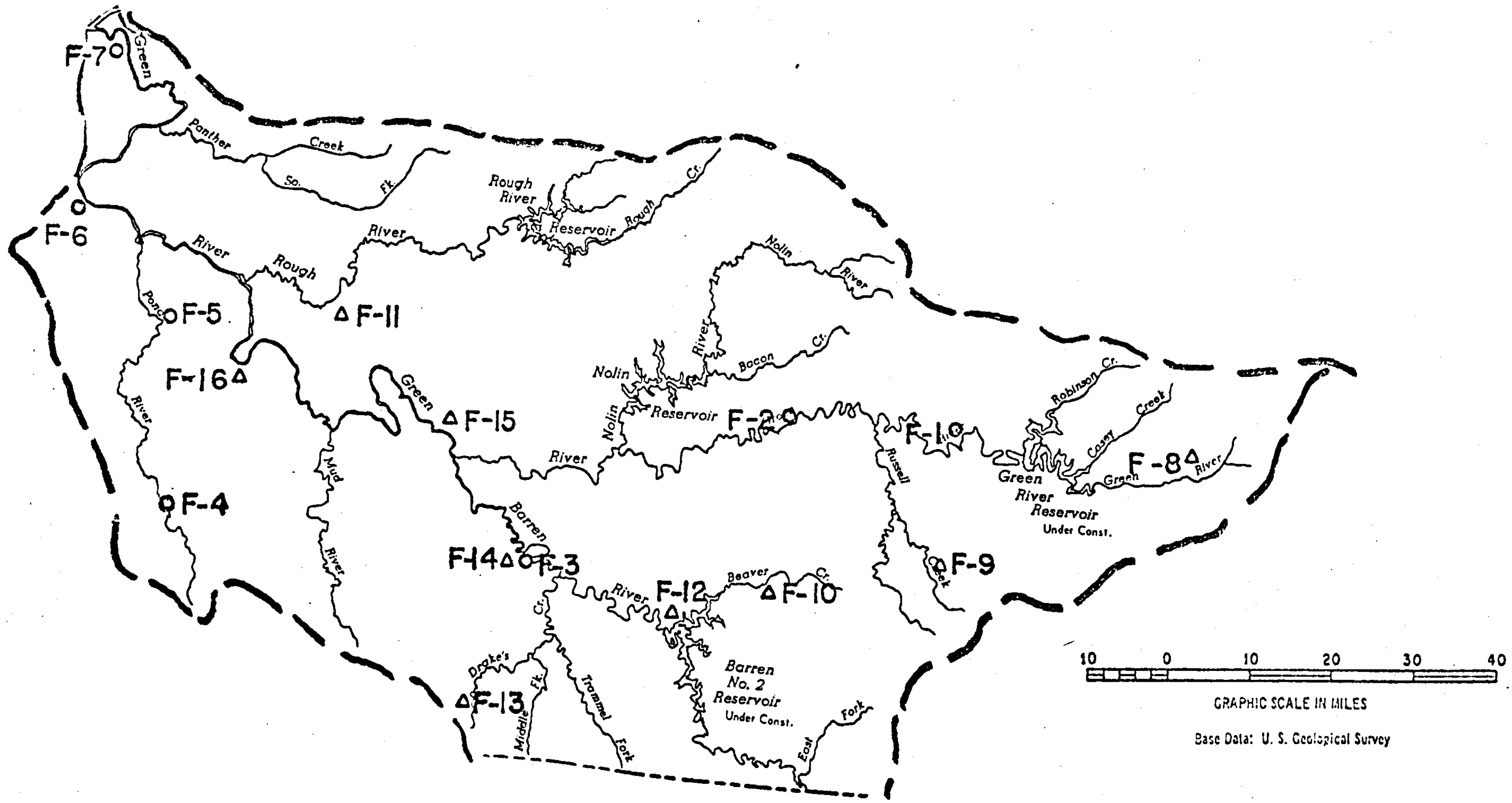
Habitat for aquatic wildlife and fishes in the basin is provided by 87 principal streams with a total length of 1,600 miles: four large Corps of Engineers' water impoundments; seven other lakes over 100 acres; and numerous smaller lakes and farm ponds. There are 190 species of fishes found in Kentucky and probably 75 percent of these can be found in the Green River Basin.

Generally, water in the basin is widely used in the agricultural industry, primarily for livestock watering with a small amount used for irrigation. In the Pond River sub-basin, water quality is sufficiently degraded so that it is not accepted for agricultural usage.

III. Summary

Water Quality in the Green River Basin is generally good. The water is slightly basic, hard, slightly salty and low in sulfates. Attention is needed, however, in the streams where coal is being produced. Since coal is expected to increase dramatically, the influence on the rest of the basin is likely to become pronounced. Also, 21 municipal discharges need to be upgraded to meet a dissolved oxygen (D.O.) concentration of 5.0 mg/l during periods of low flow. The trace chemical water quality in the Green River Basin is good with the exception of the periodic high lead levels in the Green River at Munfordville and the high fluoride levels in the Pond River at Sacramento. The exact causes of these phenomena are not known at this time and further study is needed. Further study is also needed for the quality of storm water runoff leaving large cities and developed areas and entering small streams.

GREEN RIVER


F-7
Green
Panther
Creek
So.
Fk.
Rough
River
Reservoir
Rough
Cr.
F-6
River
Rough
River
Pond
F-5
F-11
F-16
Green
F-15
River
Nolin
River
Bacon
Cr.
Nolin
Reservoir
Nolin
River
F-2
F-1
Russell
Robinson Cr.
Casey
Creek
F-8
Green
River
Green
River
Reservoir
Under Const.
River
Mud
River
F-4
Barren
F-14
F-3
River
F-12
Beaver
Cr.
F-10
F-9
Cr.
Drake's
Middle
Fk.
Trammel
Fork
F-13
Barren
No. 2
Reservoir
Under Const.
East
Fork
10
0
10
20
30
40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

STATION KEY

F-1 GREEN RIVER AT GREENSBURG
F-2 GREEN RIVER AT MUNFORDVILLE
F-3 BARREN RIVER AT BOWLING GREEN
F-4 POND RIVER AT APEX
F-5 POND RIVER AT SACREMENTO
F-6 GREEN RIVER AT BEECH GROVE
F-7 GREEN RIVER AT LOCK I
F-8 GREEN RIVER AT LIBERTY
F-9 RUSSELL CREEK AT COLUMBIA
F-10 BEAVER CREEK AT GLASGOW
F-11 ROUGH RIVER AT HARTFORD
F-12 BARREN RIVER AT BARREN RESERVOIR
F-13 DRAKES CREEK AT FRANKLIN WPI
F-14 BARREN RIVER AT BOWLING GREEN WPI
F-15 GREEN RIVER AT MORGANTOWN WPI
F-16 GREEN RIVER AT CENTRAL CITY WPI

TABLE F-1

Drainage Areas in the Green River Basin

	COUNTY AREA (SQ.MI.)	PORTION OF COUNTY (SQ.MI.)	% OF COUNTY IN BASIN
Adair	393	353	90
Allen	364	364	100
Barren	486	486	100
Breckinridge	564	243	43
Butler	443	443	100
Casey	435	341	79
Christian	726	161	22
Daviess	462	378	82
Edmonson	304	304	100
Grayson	512	512	100
Green	282	282	100
Hancock	187	29	16
Hardin	616	400	65
Hart	425	425	100
Henderson	433	121	28
Hopkins	553	278	50
Larue	260	171	65
Lincoln	340	60	17
Logan	563	329	58
McLean	257	257	100
Metcalfe	296	258	87
Monroe	334	225	68
Muhlenberg	481	481	100
Ohio	596	596	100
Pulaski	654	0.1	0.1
Russell	238	67	28
Simpson	239	143	60
Taylor	284	284	100
Todd	376	137	37
Warren	546	546	100
Webster	339	141	42
Sub total	12,988.00	8,821	68
Tennessee Area		408	
Total Drainage Basin		9,229	

Source: Soil Conservation Service Type IV Draft river basin report for the Green River, 1975

Table F-2

Slopes of Streams in the Green River Basin

Sub-basin		Average Slope (feet/mile)	Drainage Area (mi^2)
Russell Creek		5.4	289
Little Barren River		7.7	282
Nolin River -	Upper Reaches	4.7	727
	Lower Reaches	2.5	
Barren River -	Upper Reaches	7.7	2,262
	Lower Reaches	1.0	
Mud River		3.0	375
Rough River		0.8	1,081
Pond River		1.9	799
Panther Creek		1.5	374
Green River -	Upper Reaches	6.6	9,229
	Lower Reaches	n/a	

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort.

Table F-3

Locks and Dams in the Green River Basin

Lock and Dam	Mile	Length of Pool	Pool Elevation
1	9	54	349
2	63	45	363
3	108	36	380
4	145	23	396
5	168	14	411
6	182	18	421
Green River Reservoir	306		

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources

Table F-4

Coal Production by County and Type of Mining
in the Green River Basin

County	Coal Mining Methods (Tons) Strip	Underground	Auger	Total
Butler	133,100	71,100	--	204,200
Christian	80,500	--	--	80,500
Daviess	1,012,400	--	--	1,012,400
Henderson	--	92,600	--	92,600
Hopkins	2,333,600	2,752,300	76,000	5,162,600
McLean	1,108,700	--	--	1,108,700
Muhlenberg	20,843,600	5,104,200	136,000	26,083,800
Ohio	4,899,500	1,535,800	--	6,435,300
Totals	30,411,400	9,556,000	212,700	40,180,100
Percent of Totals	75	24	1	100

Source - Annual Report of the Department of Mines and Minerals for Kentucky, 1973.

Table F-5

Allowable Bench Width in Strip Mining

Slope in Degrees	Maximum Bench Width
12° - 14°	220'
15° - 18°	170'
19° - 20°	155'
21°	140'
22°	130'
23°	120'
24°	110'
25°	100'
26°	90'
27°	80'
Auger Only	
28°	60'
29° - 30°	55'
31° - 33°	45'
33° + No Fill Bench	

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Reclamation

Table F-6

Oil Production by County for Selected Years in the Green River Basin

County	Year 1969	1970	1971	1972
	-Barrels-			
Adair	7,545	275,930	330,750	293,334
Allen	61,850	47,398	39,123	36,073
Barren	11,413	10,106	12,343	11,186
Breckinridge	5,248	5,648	7,766	7,666
Butler	62,124	54,290	47,008	59,827
Casey	12,698	11,872	7,325	5,274
Christian	40,223	38,735	38,293	33,737
Daviess	997,693	786,376	720,236	584,490
Edmonson	449	428	510	368
Grayson	---	---	---	---
Green	112,019	71,042	62,950	44,604
Hancock	11,990	11,426	11,341	10,230
Hardin	---	---	---	---
Hart	16,670	15,390	15,455	13,171
Henderson	555,931	477,206	397,706	328,492
Hopkins	427,640	396,358	414,692	354,246
Larue	---	---	---	---
Logan	746	1,496	741	391
McLean	686,140	584,665	551,354	558,665
Metcalfe	81,638	74,030	62,142	486,541
Monroe	15,447	15,006	12,536	10,955
Muhlenberg	405,689	346,307	300,467	253,187
Ohio	467,421	385,412	328,608	276,390
Pulaski	---	---	---	---
Russell	158	45	49	356
Simpson	2,303	6,744	7,074	6,033
Taylor	43	255	78	---
Todd	55	---	389	453
Warren	23,770	22,364	20,380	21,919
Webster	367,382	281,785	270,452	298,728

Source: Soil Conservation Service Type IV Draft River Report for the Green River, 1975

Table F-7

Lakes in the Green River Basin

Corps of Engineers Impoundments	Seasonal Capacity	Seasonal Area
Barren River Lake	190,280	10,000 AC
Rough River Lake	90,210	5,100 AC
Nolin Lake	170,200	5,790
Green River Lake	81,500	8,200
Total	532,190 AC-Ft.	29,090 AC

Other Impoundments Over 100 Acres	Capacity (AC-Ft.)	Area (AC)
Lake Herndon	2,265	147
Valley Creek MPS#4	1,830	160
Lake Malone	14,250	826
Shanty Hollow Lake	1,607	135
Big Muddy Creek F.R.S.#2	375	105
Mill Creek MPS#4	1,705	109
Mud River MPS#6A	3,218	240
Peabody Coal - New River Queen Slurry Dam	3,907	162
Peabody Coal - Alston Mine-Area VI Dam	1,180	50
Total	30,330 AC-Ft.	1,930 AC

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources

TABLE F-8

Population Distribution in the Green River Basin

COUNTY	1970 URBAN POPULATION**	TOTAL RURAL	TOTAL POPULATION* IN BASIN
Adair	3234	9803	12,100
Allen			12,600
Barren			28,700
Breckinridge	4235	10554	4,550
Butler			9,720
Casey	1765	11165	8,760
Christian	22665	33559	7,450
Daviess	51081	28405	24.000
Edmonson			8,750
Grayson			16,500
Green			10,400
Hancock	2857	4223	670
Hardin	26520	51901	45,800
Hart			14,000
Henderson	23856	12175	3,400
Hopkins	23637	14530	27,900
Larue	3114	7558	8,100
Lincoln	3748	12915	2,270
Logan	9240	7607	15,900
McLean			9,060
Metcalfe	958	7219	7,250
Monroe	2766	8876	8,760
Muhlenberg			27,500
Ohio			18,800
Pulaski			0
Russell	2668	7874	2,210
Simpson	6553	6501	10,500
Taylor	7598	6540	17,000
Todd	3308	7515	2,530
Warren			57,400
Webster	7865	5417	3,620
Total	150,000	276,000	426,000

* Approximate measurement ± 10 per cent based on U.S. Census Data

** U. S. Census Data

Table F - 9

City Population and Facility Grant Status in the Green River Basin in Kentucky

County	City	Population	Project Type	Comments
Adair	Columbia	3,234	I	Underway
Allen	Scottsville	3,584	I	Underway
Barren	Cave City	1,818	None	Sewered
	Park City	567	None	No Sewers
	Glasgow	11,301	I	Pending
Breckinridge				
Butler	Morgantown	1,394	I	Underway
Casey	Liberty	1,765	I	Underway
Christian				
Daviess	Whitesville	752	I	No Sewers
Edmonson	Brownsville	542	None	Sewered
Grayson	Caneyville	530	I	Pending
	Leitchfield-	2,983	I	Underway
	Clarkson	660		
Green	Greensburg	1,990	None	Sewered
Hancock				
Hardin	Sonora	390	None	No Sewers

Table F - 9
Continued

County	City	Population	Project Type	Comments
Hardin (con't)	Elizabethtown	11,748	I	Underway
Hart	Munfordsville	1,233	None	Sewered
	Horse Cave	2,068	None	Sewered
	Bonnieville	328	I	Pending
Henderson				
Hopkins	Madisonville-	15,332	I	Underway
	Earlington	2,321		
	Hanson	378		
	Morton's Gap	1,169	None	No Sewers
	Nortonville	699	I	Pending
	White Plains	729	None	No Sewers
Larue	Upton	552	None	No Sewers
	Hodgenville	2,562	I	Underway
Lincoln				
Logan	Auburn	1,160	None	Sewered
	Lewisburg	651	None	Sewered
McLean	Calhoun	901	III	STP only
	Sacramento	437		No Sewers
	Island	410	I	No Sewers
	Livermore	1,594	I	Underway
Metcalfe	Edmonton	958	I	Pending

Table F - 9
Continued

County	City	Population	Project Type	Comments
Monroe	Gamaliel	431	None	No Sewers
	Tompkinsville	2,207	I	Underway
	Fountain Run	128	I	
Muhlenburg	Greenville-Central City	9,325	I	Underway
	Powderly	631		
	Drakesboro	907	I	No Sewers
Ohio	Beaver Dam-Hartford	2,622	I	Pending
		1,868		
	McHenry	420		
	Fordsville	489	I	No Sewers
	Centertown	323	None	No Sewers
	Rockport	377	I	No Sewers
Pulaski				
Russell				
Simpson	Franklin	6,553	I	Underway
Taylor	Campbellsville	7,598	I	Underway
Todd				
Warren	Smiths Grove	756		No Sewers
	Woodburn	351		No Sewers
	Bowling Green	36,253	I	Underway
Webster	Slaughters	276	I	Underway
	Sebree	1,092	None	Sewered

Table F - 9
Continued

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U. S. Census and the FY 75 construction grants list for Kentucky.

Table F-10

Water Quality Date for Green River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
STORET #00400	pH Specific Units Ky. Std. 6 LT pH LT 9						
Green R., Greensburg	70/03/03	72/08/24	7.3	7.8	7.1	9	.250
	65/01/20	72/08/24	7.4	8.1	6.9	50	.258
	59/10/14	72/08/24	7.2	8.1	6.4	113	.317
Green R., Munfordville	70/01/10	73/09/12	7.7	8.4	6.8	90	.392
USGS 03308500	65/01/12	73/09/12	7.7	8.6	6.8	208	.366
	59/10/09	73/09/12	7.6	9.6	6.5	400	.405
Barren R., Bowling Green	75/06/03	75/06/03	6.1			1	
USGS 03314500	70/02/11	74/04/09	7.8	8.1	7.5	12	.241
	65/11/09	74/04/09	7.7	8.2	6.8	31	.330
	59/10/16	74/04/09	7.5	8.2	6.6	45	.396
Pond R., nr. Apex	70/09/25	72/08/17	7.5	8.0	7.0	3	.503
USGS 03320500	61/04/12	72/08/17	7.4	8.0	6.9	5	.439
Pond R. nr. Sacramento	70/03/03	73/07/16	4.8	7.0	3.3	14	1.45
USGS 03321100	65/02/05	73/07/16	4.4	7.0	2.8	32	1.34
	59/10/17	73/07/16	4.0	7.0	2.8	73	1.39
Green R., nr. Beech Grove	75/01/07	75/12/08	7.1	7.6	6.4	12	.420
USGS 03321230							
Green R. at Lock 1	70/04/14	72/08/16	7.5	7.9	6.9	10	.374
USGS 03321500	66/01/19	72/08/16	7.5	8.1	6.9	27	.306
	59/10/10	72/08/16	7.4	8.1	6.8	35	.317
STORET #00095	Conductivity Micromhos						
Green R., Greensburg	70/01/21	72/08/24	144.3	202.0	120.0	18	20.8
	65/01/20	72/08/24	175.3	940.0	98.0	73	98.3
	59/10/14	72/08/24	194.5	2570.0	72.0	137	230.3
Green R., Munfordville	70/01/10	73/09/12	270.9	553.0	133.0	90	103.1
	65/01/12	73/09/12	337.9	1380.0	47.0	217	192.2
	59/10/09	73/09/12	549.9	942.0	47.0	432	732.5

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Barren R., Bowling Green	75/04/23	75/11/12	215.0	280.0	145.0	5	52.4
	70/02/11	74/09/11	243.3	298.0	182.0	20	29.9
	65/11/09	74/09/11	252.0	321.0	182.0	53	32.5
	59/10/16	74/09/11	251.8	321.0	116.0	67	36.1
Pond R., nr. Apex	75/08/28	75/11/11	259.0	340.0	250.0	2	63.6
	70/09/25	75/11/11	352.4	483.0	207.0	5	128.1
	70/09/25	72/08/17	390.7	483.0	207.0	3	159.1
	61/04/12	72/08/17	332.4	483.0	207.0	5	138.9
Pond R., nr. Sacramento	70/03/03	73/07/16	1108.5	2140.0	515.0	17	565.4
	65/02/05	73/07/16	1406.6	3230.0	143.0	41	881.9
	59/10/17	73/07/16	1169.1	3230.0	143.0	82	800.6
Green R., Beech Grove	75/01/07	75/12/08	308.8	500.0	190.0	12	89.5
	74/10/16	75/12/09	267.7	280.0	260.0	3	10.8
Green R. at Lock 1	70/01/26	72/08/16	294.9	402.0	237.0	18	47.4
	66/01/19	72/08/16	316.2	479.0	234.0	39	63.6
	59/10/10	72/08/16	378.3	1080.0	154.0	84	177.0
STORET #70300	Dissolved Solids mg/l Ky. Std. 500						
Green R., Greensburg	70/03/03	72/08/24	93.4	124.0	77.0	9	15.4
	65/01/20	72/08/24	110.1	496.0	58.0	50	60.3
	59/10/14	72/08/24	107.8	566.0	58.0	112	61.2
Green R., Munfordville	70/01/10	73/09/12	159.2	296.0	76.0	90	58.7
	65/01/12	73/09/12	195.7	768.0	61.0	215	104.8
	59/10/09	73/09/12	309.7	5830.0	61.0	422	430.3
Barren R., Bowing Green	75/04/23	75/07/15	113.3	144.0	82.0	3	31.0
	65/11/09	74/09/11	148.8	177.0	104.0	33	18.2
	59/10/16	74/09/11	147.2	177.0	82.0	45	19.6
Pond R. nr. Apex	70/09/25	72/08/17	230.0	278.0	138.0	3	79.7
Pond R. nr. Sacramento	70/03/03	73/07/16	957.7	2020.0	332.0	14	587.9
	60/02/05	73/07/16	1084.2	2960.0	128.0	31	754.9
	59/10/17	73/07/16	856.3	2960.0	128.0	72	665.0
Green R., Beech Grove	75/01/07	75/11/17	186.1	319.0	104.0	11	68.7
	74/10/16	74/12/09	179.0	184.0	169.0	3	8.7

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Lock 1	70/04/14	72/08/16	184.2	259.0	128.0	10	44.3
	66/01/19	72/08/16	195.9	298.0	128.0	27	44.6
	59/10/10	72/08/16	223.4	572.0	105.0	69	88.4
STORET #00410	Alkalinity mg/l						
Green R., Greensburg	70/03/03	72/08/24	53.8	75.0	43.0	9	9.8
	66/10/19	72/08/24	61.1	114.0	30.0	21	20.6
	59/10/14	72/08/24	60.7	114.0	30.0	35	17.5
Green R., Munfordville	70/01/10	73/09/12	90.7	141.0	40.0	90	27.8
	65/01/31	73/09/12	95.2	141.0	40.0	167	26.7
	59/10/09	73/09/12	95.5	153.0	40.0	220	25.3
Barren R., Bowling Green	75/04/23	75/07/15	77.0	94.0	57.0	3	18.7
	70/02/11	74/09/11	99.6	125.0	74.0	14	13.3
	67/10/02	74/09/11	99.6	125.0	74.0	25	12.5
	59/10/16	74/09/11	102.4	141.0	46.0	39	17.1
Pond R., nr. Apex	70/09/25	72/08/17	106.3	124.0	74.0	3	28.0
	61/04/12	72/08/17	91.0	124.0	60.0	5	29.4
Pond R., nr. Sacramento	70/03/03	73/07/16	7.4	43.0	.00	14	12.2
	67/04/05	73/07/16	5.6	43.0	.00	25	10.9
	59/10/17	73/07/16	8.7	57.0	.00	50	12.7
Green R., Beech Grove	75/01/17	75/11/17	81.9	106.0	52.0	11	19.1
	74/10/16	74/12/09	81.7	93.0	76.0	3	9.8
Green R., Lock 1	70/04/14	72/08/16	75.9	94.0	57.0	10	12.8
	66/10/18	72/08/16	74.2	107.0	44.0	21	16.5
	59/10/31	72/08/16	79.1	119.0	44.0	39	17.7
STORET # 00900	Hardness (mg/l) Ky. Std., o-60 soft, 61-120 hard, 121-180 hard, over 180 very hard.						
Green R., Greensburg	70/03/03	72/08/24	67.9	92.0	55.0	9	10.9
	65/01/20	72/08/24	77.7	195.0	44.0	50	26.8
	59/10/14	72/08/24	78.9	358.0	35.0	103	37.5

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Munfordville	70/01/10	73/09/12	110.4	170.0	59.0	90	33.4
	65/01/12	73/09/12	123.7	387.0	50.0	207	44.9
	59/10/09	73/09/12	95.5	153.0	40.0	220	25.3
Barren R., Bowling Green	75/04/23	75/07/15	90.3	110.0	71.0	3	19.5
	70/02/11	74/09/11	118.4	140.0	86.0	14	15.1
	65/11/09	74/09/11	122.2	157.0	86.0	33.0	16.9
	59/10/16	74/09/11	102.4	141.1	46.0	39.0	17.1
Pond R., nr. Apex	70/09/25	72/08/17	135.7	170.0	90.0	3	41.2
	61/04/12	72/08/17	115.8	170.0	80.0	5	40.1
Pond R., nr. Sacramento	70/03/03	73/07/16	560.7	1200.0	220.0	13	324.0
	65/02/05	73/07/16	620.7	1540.0	58.0	31	403.0
	59/10/17	73/07/16	487.9	1540.0	58.0	67	369.9
Green R., Beech Grove	75/01/07	75/11/17	142.3	220.0	95.0	11	44.1
	74/10/16	74/12/09	130.0	140.0	120.0	3	10.0
Green R., Lock 1	70/04/14	72/08/16	133.1	180.0	110.0	10	23.7
	66/01/19	72/08/16	137.9	200.0	94.0	27	27.5
	59/10/10	72/08/16	137.2	225.0	64.0	72	34.3

STORET #00080 Color Platinum-Cobalt units EPA Std. 75 units

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Greensburg	71/04/07	71/04/07	3.0			1	
	65/01/20	71/04/07	6.8	25.0	2.0	21	5.11
	59/10/14	7/04/07	11.6	130.0	1.0	82	15.8
Green R., Munfordville	70/11/01	72/10/15	1.7	5.0	.00	3	2.88
	65/01/12	72/10/15	9.9	50.0	.00	67	9.53
	59/10/09	72/10/15	9.2	55.0	.00	253	9.53
Barren R. at Bowling Green	71/03/15	71/03/15	.00			1	
	66/07/20	71/03/15	3.2	5.0	.00	5	2.16
	59/10/16	71/03/15	5.9	38.0	.00	17	8.49
Pond R., nr. Sacramento	70/12/01	73/07/16	4.0	5.0	2.0	3	1.73
	65/02/05	73/07/16	4.5	7.0	5.0	8	2.17
	59/10/17	73/07/16	7.0	56.0	55.0	46	10.8

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Lock 1	71/04/27	71/04/27	3.0			1	
	66/07/22	71/04/27	6.8	17.0	3.0	5	5.76
	59/10/10	71/04/27	7.0	40.0	1.0	48	8.25
STORET #00930	Sodium No Standard						
Green R., Greensburg	71/04/07	71/04/07	2.20			1	
	65/11/09	71/04/07	11.3	108.0	2.2	13	29.1
	59/10/14	71/04/07	7.8	121.0	1.60	51	21.9
Green R., Munfordville	70/11/01	72/10/15	25.7	45.0	12.0	3	17.2
	68/11/25	72/10/15	48.0	84.0	12.0	5	33.0
	59/11/08	72/10/15	76.7	478.0	3.5	54	99.5
Barren R., Bowling Green	75/04/23	75/07/15	2.0	2.5	1.5	3	.503
	71/03/15	74/09/11	3.4	4.6	2.3	4	.971
	66/07/20	74/09/11	4.1	5.6	2.3	8	1.04
	59/10/16	74/09/11	3.7	5.6	2.1	21	1.0
Pond R., nr. Sacramento	70/2/01	73/07/16	28.3	46.0	17.0	3	15.5
	59/10/17	73/07/16	39.1	139.0	5.4	38	31.3
Green R., Beech Grove	75/01/17	75/11/17	6.5	15.0	3.0	11	3.77
	74/10/16	74/12/09	6.0	6.6	5.5	3	.568
Green R., Lock 1	71/04/27	71/04/27	12.0			1	
	66/07/22	71/04/27	12.1	18.0	6.8	5	4.59
	59/10/10	71/04/27	27.9	132.0	4.2	56	28.0
STORET #00935	Potassium mg/l No Standard						
Green R., Greensburg	71/04/07	71/04/07	1.7			1	
	65/11/09	71/04/07	1.7	3.4	.9	13	.728
	59/10/14	71/04/07	1.5	3.4	.4	51	.630
Green R., Munfordville	70/11/01	72/10/15	2.3	2.7	2.0	3	.361
	68/11/25	72/10/15	2.5	2.9	2.0	5	.370
	59/11/26	72/10/15	2.1	5.2	.8	21	.957
Barren R., Bowling Green	75/04/23	75/07/15	2.7	5.0	1.5	3	1.99
	71/03/15	74/09/11	1.8	2.6	1.0	4	.750
	66/07/20	74/09/11	1.8	2.6	1.0	8	.607
	59/10/16	74/09/11	1.4	2.6	.50	21	.586

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Pond R., nr. Sacramento	70/12/01	73/07/16	7.5	15.0	3.6	3	6.52
	66/09/08	73/07/16	6.4	15.0	3.6	7	3.91
	59/10/17	73/07/16	3.5	15.0	.9	38	2.52
Green R., Beech Grove	75/01/07	75/11/17	2.4	6.0	1.5	11	1.28
	74/10/16	74/12/09	2.1	2.5	1.7	3	.404
Green R., Lock 1	71/04/27	72/04/27	2.4			1	
	66/07/22	72/04/27	2.2	2.9	1.6	5	.484
	59/10/10	71/04/27	1.9	4.1	.9	54	.738

STORET #00940 Chloride mg/l Prep. EPA Std. 250 mg/l

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Greensburg	70/03/03	72/08/24	2.9	3.7	2.1	9	.603
	65/01/20	72/08/24	8.1	212.0	1.0	50	29.5
	59/10/14	72/08/24	15.4	750.0	1.0	114	75.4
Green R., Munfordville	70/01/10	73/09/12	19.2	80.0	3.0	90	17.5
	65/01/12	73/09/12	37.1	350.0	3.0	217	48.6
	59/10/09	73/09/12	104.4	3250.0	3.0	425	241.6
Barren R., Bowling Green	75/04/23	75/07/15	4.3	6.4	2.9	3	1.83
	70/02/11	74/09/11	5.5	6.9	3.5	14	1.01
	65/11/09	74/09/11	6.5	11.0	3.5	33	1.71
	59/10/16	74/09/11	6.7	11.0	3.5	47	1.8
Pond R., Apex	61/04/12	72/08/17	33.7	64.0	9.5	5	25.8
Pond R., nr. Sacramento	70/03/03	73/07/16	14.2	31.0	8.7	14	6.46
	65/02/05	73/07/16	16.5	46.0	4.5	31	9.54
	59/10/17	73/07/16	33.0	318.0	4.5	71	44.7
Green R., Beech Grove	75/01/07	75/11/17	6.3	14.0	3.2	11	3.21
	74/10/16	74/12/09	6.3	6.7	5.8	3	.458
Green R., Lock 1	70/04/14	72/08/16	9.1	13.0	5.0	10	2.47
	66/01/19	72/08/16	12.5	28.0	5.0	27	5.75
	59/10/10	72/08/16	39.4	254.0	5.0	72	51.4

STORET #00945 Sulfate mg/l Prop. EPA Std 250 mg/l

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Greensburg	70/03/03	72/08/24	15.3	19.0	14.0	9	1.93
	65/01/20	72/08/24	17.0	46.0	12.0	50	5.45
	59/10/14	72/08/24	15.5	46.0	9.6	113	21.2
Green R., Munfordville	70/01/10	73/09/12	16.5	29.0	9.0	90	3.39
	65/01/12	73/09/12	18.1	35.0	9.0	207	4.72
	59/10/09	73/09/12	17.9	106.0	7.4	398	7.05
Barren R., Bowling Green	75/04/23	75/07/15	13.3	17.0	10.0	3	3.51
	70/02/11	74/09/11	18.7	30.0	13.0	14	4.75
Pond R., nr. Apex	70/09/25	72/08/17	22.0	32.0	16.0	3	8.72
	61/04/12	72/08/17	20.2	32.0	16.0	5	6.65
Pond R., Sacramento	70/13/03	73/07/16	628.0	1400.0	200.0	14	401.1
	65/02/05	73/07/16	776.6	1900.0	139.0	31	551.4
	59/10/17	73/07/16	569.0	1900.0	62.0	72	491.3
Green R., Beech Grove	75/01/07	75/11/17	57.8	120.0	16.0	11	33.1
	74/10/16	74/12/09	45.7	47.0	43.0	3	2.31
Green R., Lock 4	70/04/14	72/08/16	59.6	93.0	34.0	10	19.8
	66/01/19	72/08/16	62.2	107.0	32.0	27	19.8
	59/10/10	72/08/16	51.1	107.0	17.0	72	21.5
STORET #00618	Nitrate mg/l Prop.EPA Std. 10 mg/l						
Green R., Greensburg	72/07/20	72/08/24	.30			1	
	66/10/19	72/08/24	.44	1.0	.16	4	.379
	60/10/11	72/08/24	.43	1.0	.09	6	.360
Green R., Munfordville	71/11/26	73/09/12	.88	1.60	.40	46	.278
	61/04/12	73/09/12	.86	1.60	.34	47	.286
Barren R., Bowling Green	75/04/23	75/07/15	.62	.72	.49	3	.131
	71/12/29	74/09/11	.87	1.20	.52	7	.212
Pond R., nr. Apex	72/08/17	72/08/17	.69			1	
Pond R., nr. Sacremento	71/08/05	73/07/16	.42	.70	.18	7	.248
Green R., Lock 1	72/02/09	72/08/16	1.4	2.0	.9	3	.513

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
STORET #00950	Fluoride mg/l Ky. Std. 1.0 mg/l						
Green R., Greensburg	70/09/08	72/08/24	.075	.10	.00	4	.050
	65/11/09	72/08/24	.118	.50	.00	16	.155
	59/10/14	72/08/24	.147	.50	.00	55	.116
Green R., Munfordville	70/09/09	72/10/27	.142	.20	.10	7	.053
	68/11/25	72/10/27	.144	.20	.10	9	.053
	59/10/15	72/10/27	.183	.50	.10	36	.102
Barren R., Bowling Green	75/04/23	75/07/15	.033	.10	.00	3	.058
	70/09/14	74/09/11	.125	.30	.00	8	.089
	66/07/20	74/09/11	.133	.30	.00	12	.078
Pond R., nr., Apex	70/09/25	72/08/17	.133	.20	.10	3	.058
	61/04/12	72/08/17	.120	.20	.10	5	.045
Pond R., nr. Sacramento	70/09/15	73/07/16	1.36	3.30	.50	7	.950
	65/10/13	73/07/16	1.60	3.30	.30	13	.976
	59/10/17	73/07/16	1.03	3.30	.00	44	.962
Green R., nr. Beech Grove	75/01/07	75/11/17	.155	.40	.00	11	.113
	74/10/16	74/12/09	.133	.20	.10	3	.058
Green R., Lock 1	70/09/15	72/08/16	.20	.50	.00	5	.187
	66/07/22	72/08/16	.20	.50	.00	9	.141
	59/10/10	72/08/16	.192	.50	.00	51	.084
STORET #00915	Calcium mg/l No Std.						
Green R., Greensburg	71/04/07	71/04/07				1	
	65/11/09	71/04/07	27.9	55.0	16.0	13	11.0
	59/10/14	71/04/07	23.2	55.0	9.6	51	8.74
Green R., Munfordville	70/01/10	73/09/12	19.2	80.0	3.0	90	17.5
	65/01/12	73/09/12	37.1	350.0	3.0	217	48.6
	59/10/09	73/09/12	104.4	3250.0	3.0	425	241.6
Barren R., Bowling Green	75/04/23	75/07/15	28.0	34.0	22.0	3	6.00
	71/03/15	74/09/11	31.8	35.0	26.0	4	4.03
Pond R., nr. Sacramento	70/12/01	73/07/16	139.3	270.0	61.0	3	113.9
	66/09/08	73/07/16	172.1	270.0	61.0	7	76.1
	59/10/17	73/07/16	97.0	274.0	18.0	38	70.0

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max	Min.	#OBS	s
STORET #01030	Chromium micrograms/liter Ky. Std. 50 ug/l						
Green R., Greensburg	75/07/18	75/11/27	2.7	8.0	.00	3	4.62
Barren R., Bowling Green	75/08/25	75/11/12	.00	.00	.00	2	.00
Pond R., nr. Apex	75/08/28	75/11/11	.00	.00	.00	2	.00
Green R., Beech Grove	75/01/07	75/10/20	.250	1.0	.00	4	.500
	74/10/16	74/10/16	1.0			1	
STORET #01049	Lead micrograms/liter Ky. Std. 50 ug/l						
Green R., Greensburg	75/07/18	75/11/20	8.3	18.0	3.0	3	8.39
Green R., Munfordville	65/01/10	65/09/17	.00	.00	.00	9	.00
	62/11/12	65/09/17	.00	.00	.00	29	.00
Barren R., Bowling Green	75/08/25	75/11/12	7.0	14.0	.00	2	9.90
Pond R., nr. Apex	75/08/28	75/11/11	3.0	6.0	.00	2	4.24
Pond R., nr. Sacramento	62/10/31	64/08/05	.00	.00	.00	4	.00
Green R., Beech Grove	75/01/07	75/10/20	2.25	5.0	.00	4	2.63
	74/10/16	74/10/16	9.0			1	
STORET #01000	Arsenic Micrograms/liter Ky. Std. 50 ug/l						
Green R., Greensburg	75/07/18	75/11/20	.00	.00	.00	3	.00
Green R., Munfordville	65/01/10	65/09/17	.00	.00	.00	9	.00
	62/11/12	65/09/17	.00	.00	.00	29	.00
Barren R., Bowling Green	75/08/25	75/11/12	.00	.00	.00	2	.00
Pond R., nr. Apex	75/08/28	75/11/11	.00	.00	.00	2	.00
Pond R., nr. Sacramento	62/10/31	64/08/05	.00	.00	.00	4	.00

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Green R., Beech Grove	75/01/07	75/10/20	.25	1.0	.00	4	.500
	74/10/16	74/10/16	.00			1	

Bacteriological Data

STORET #31503 Total Coliform colinies per 100 ml Ky. Std 1000/100 ml
STORET #31616 Fecal Coliform colinies per 100 ml

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.
Green River, Liberty						
Total Coliform	75/01/06	75/12/04	169	488	0	14
	74/03/25	75/12/04	235	600	0	28
Fecal Coliform	75/01/06	75/02/18	27	65	11	4
	74/10/25	75/03/18	78	238	11	8
Green R., Greensburg						
Total Coliform	74/03/19	74/12/16	606	1157	137	15
Fecal Coliform	74/10/25	74/12/02	35	54	19	3
Russell Crk.,Columbia						
Total Coliform	75/01/06	75/12/19	5220	50400	97	20
	74/03/25	75/12/19	356	1053	0	29
Fecal Coliform	75/01/06	75/02/18	39	104	4	4
	74/10/25	75/02/18	95	321	4	9
Green River, Munfordsville						
Total Coliform	75/01/08	75/12/18	182	800	0	13
	74/04/16	75/12/18	382	2000	0	29
Fecal Coliform	75/01/06	75/02/18	17	50	5	4
	74/01/06	75/02/18	25	66	5	7
Rough River Hartford						
Total Coliform	75/01/08	75/12/18	1335	6550	0	11
	74/04/16	75/12/18	1027	6550	0	22
Fecal Coliform	75/01/24	75/12/18	1558	3900	139	5

Table F-10
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Beaver Cr., Glasgow							
Total Coliform	75/01/06	75/12/04	210	484	0	13	
	74/03/25	75/12/04	228	700	0	15	
Fecal Coliform	75/01/06	75/05/12	5	126	0	3	
Barren River below Barren R. Reservoir							
Total Coliform	75/01/25	75/12/04	14	60	0	12	
	74/03/25	75/02/18	103	1333	0	25	
Fecal Coliform	75/01/25	75/02/18	24	126	0	6	
Drakes Cr., Franklin WPI							
Total Coliform	75/01/07	75/12/17	1605	7800	98	11	
	74/04/15	75/12/17	2755	19700	0	21	
Fecal Coliform	75/10/22	75/11/25	1553	3033	73	2	
Barren R. Bowling Green WPI							
Total Coliform	75/01/07	75/12/17	262	800	5	12	
	74/04/15	75/12/17	1236	13100	5	22	
Fecal Coliform	75/10/22		344			1	
Green R. Morgantown WPI							
Total Coliform	75/01/08	75/12/15	310	933	16	12	
	74/04/16	75/12/15	707	3600	16	23	
Green R., Central City WPI							
Total Coliform	75/01/08	75/12/18	975	4167	0	12	
	74/05/14	75/12/18	4451	52000	0	20	
Fecal Coliform	75/07/22	75/12/18	511	1303	0	3	

Table F
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., nr. Beech Grove	75/01/07	75/11/17	41.2	60.0	30.0	11	9.88
	74/10/16	74/12/09	37.0	41.0	33.0	3	4.00
Green R., Lock 1	71/04/27	71/04/27	51.0			1	
	66/07/22	71/04/27	44.2	52.0	27.0	5	10.2
	59/10/10	71/04/27	39.7	65.0	20.0	56	10.1
STORET #00925	Magnesium mg/l No Std.						
Green R., Greensburg	71/04/07	71/04/07	4.9			1	
	65/11/09	71/04/07	6.08	14.0	3.9	13	2.59
	59/10/14	71/04/07	6.05	43.0	1.70	51	5.75
Green R., Munfordville	70/11/01	72/10/15	8.83	12.0	6.8	3	2.78
	68/11/25	72/10/15	10.5	14.0	6.8	5	3.09
	59/10/09	72/10/15	11.7	80.0	2.5	143	10.3
Barren R., Bowling Green	75/04/23	75/07/15	5.07	6.5	3.8	3	1.36
	71/03/15	74/09/11	5.7	6.4	5.0	4	.680
Pond R., nr. Sacramento	70/12/01	73/07/16	63.7	130.0	22.0	3	58.1
	66/09/08	73/07/16	97.3	158.0	22.0	7	48.5
	59/10/17	73/07/16	44.6	158.0	5.8	38	40.2
Green R., nr. Beech Grove	75/01/07	75/11/17	9.3	17.0	4.2	11	4.00
	74/10/16	74/12/09	8.4	8.5	8.3	3	.101
Green R., Lock 1	71/04/27	71/04/27	12.0			1	
	66/07/22	71/04/27	11.9	16.0	6.3	5	3.51
	59/10/10	71/04/27	9.2	18.0	3.5	56	3.35
STORET #01025	Cadmium micrograms/liter Ky. Std. 100 ug/l						
Green R., Greensburg	75/07/18	75/11/20	1.0	3.0	.0	3	1.73
Green R., Munfordville	65/01/10	65/09/17	.00			9	
	62/11/12	65/09/17	.00			29	
Barren R., Bowling Green	75/08/25	75/11/12	3.0	4.0	2.0	2	1.41
Pond R., nr. Apex	75/08/28	75/11/11	2.5	5.0	.00	2	3.54
Pond R., nr. Sacremento	62/10/31	64/08/05	.00			1	

Table F
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Beech Grove	75/01/07	75/10/20	1.3	4.0	.00	4	1.89
	74/10/16	74/10/16	.00			1	

STORET #01056 Manganese micrograms/liter Prop. Ky. Std. 50 ug/l

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R., Greensburg	72/07/20	72/08/24	74.0	87.0	61.0	2	18.4
	59/10/14	72/08/24	158.9	410.0	.00	11	134.2
Barren R., Bowling Green	71/12/29	72/07/25	61.2	96.0	29.0	4	28.2
	59/10/16	72/07/25	301.9	2400.0	.00	13	641.1
Pond R., nr. Apex	61/10/05	61/10/05	330.0			1	
Pond R., nr. Sacramento	71/11/18	73/07/16	8839.9				
Green R., Beech Grove	75/01/07	75/10/20	155.0	380.0	10.0	4	176.0
	74/10/16	74/10/16	250.0			1	
Green R., Lock 1	72/05/09	72/05/09	180.0			1	

STORET #01046 Iron micrograms/liter, Prop EPA Std. 300 ug/l

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
Green R. Greensburg	72/07/20	72/08/24	125.0	150.0	100.0	2	35.4
	59/10/14	72/08/24	240.0	1100.0	80.0	14	266.4
Green R., Munfordville	65/01/02	66/09/24	54.0	330.0	.00	15	84.2
Barren R., Bowling Green	71/12/29	72/07/25	100.0	200.0	.00	4	95.2
	59/10/16	72/07/25	288.6	2400.0	.00	14	611.9
Pond R. nr. Apex	61/10/05	61/10/05	190.0			1	
Pond R., nr. Sacramento	71/11/18	73/07/16	1202.0	2200.0	570.0	5	745.8
	59/10/17	73/07/16	1076.4	3200.0	90.0	25	874.5
Green R., Beech Grove	75/01/07	75/10/20	25.0	60.0	.00	4	26.5
	74/10/16	74/10/16	10.0			1	
Green R., Lock 1	72/05/09	72/05/09	370.0			1	

Table F-11

Organic Loads Affecting Streams in the Green River Basin

Length of streams to which treated organic loads are discharged		1,670
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow with present treatment		214
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to with present treatment	Municipal Discharges	173
	Industrial Discharges	6.8
	Other Discharges	34.5

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q 10-7) low flow.

Table F-12

Water Usage for Industry and the Public in the Green River Basin

County	City	Surface Public	Surface Industrial	Ground Public	Ground Industrial
Adair	Columbia	267,000	2,700		
Allen	Scottsville			456,000	114,000
Barren	Glasgow Res.	867,000			
	Glasgow Creek	1,300,000	229,000		
	Park City			40,000	
Breckinridge	Kingswood			15,000	
Butler	Morgantown	180,000			
	Rochester	27,700	300		
Casey	Liberty	116,000	38,800		
Christian					
Daviess	Whitesville			40,400	
Edmonson	Bee Spring			1,360	
	Edmonson C.W.D.	265,000			
	Brownsville			60,100	
	Mammoth Cave			73,600	
Grayson	Caneyville	22,300	500		
	Leitchfield			279,000	45,400
Green	Gabe	3,500	172,000		
	Greensburg	172,000	43,000		
	Nally Gibson		24,000		
Hancock					
Hardin	Elizabethtown			1,630,000	16,400
	Upton			45,000	5,000
Hart	Horse Cave			525,000	45,700
	Munfordsville	82,100	11,200		
Henderson	Anaconda Alum.		639,000		

Table F-12
Continued

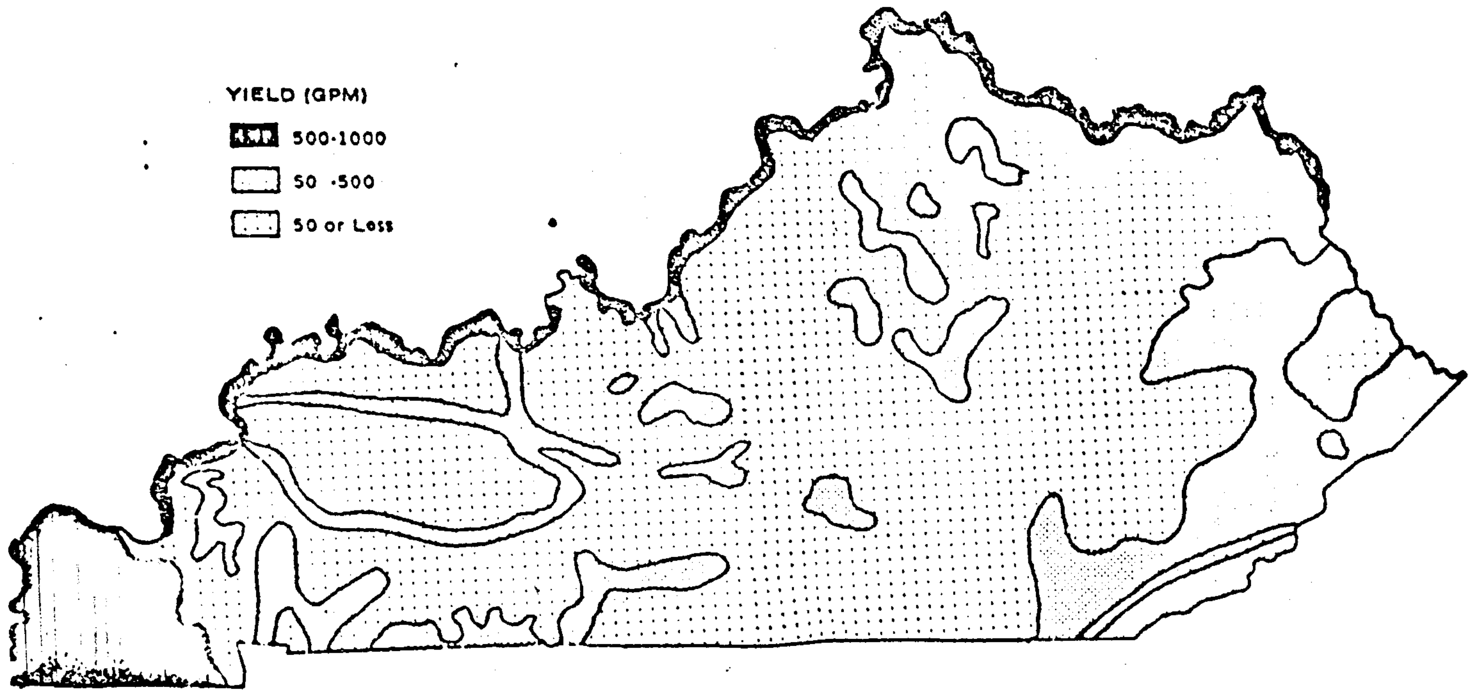
County	City	Surface Public	Surface Industrial	Ground Public	Ground Industrial
Hopkins	Earlington	148,000			
	Madisonville	1,790,000	268,000		
	Nortonville			75,600	3,900
	White Plains			17,100	900
	Cimmarron Coal		288,000		
	Island Creek Coal		39,800		
Larue	Hodgenville	190,000			
	Auburn Dyeing		12,700		
	Auburn			93,200	23,200
	Caldwell Lace		25,700		
	Lewisburg	43,300	4,800		
	Russellville	436,000	387,000	16,900	14,900
McLean	Calhoun	133,000	133,000		
	Livermore	128,000	14,200		
	Sacramento			19,750	
Metcalfe	Edmonton	48,800	5,400		
Monroe	Gamaliel Res and Creek	49,000			
	Tompkinsville	125,000	75,000		
Muhlenberg	Central City	713,000	75,000		
	Gilbrater Coal		1,520,000		
	Pittsburg Midway		164,000		
	Drakesboro			102,000	1,000
	Graham	17,100	175		
	Greenville	323,000	17,000		
	Kirkpatrick Mine		35,000		
	Wright Coal (Madisonville)		79,400		
	Peabody Coal (Beaver Dam)		739,000		
Ohio	Peabody Coal		469,000		
	Fordsville	48,000			
	Hartford	227,000	12,000		
	Ohio C.W.D.	310,000	77,500		
	Rockport	60,400			
	Peabody Coal (Hartford)		288,000		
	Peabody Coal		590,000		
Pulaski					
Russell					

Table F-12
Continued

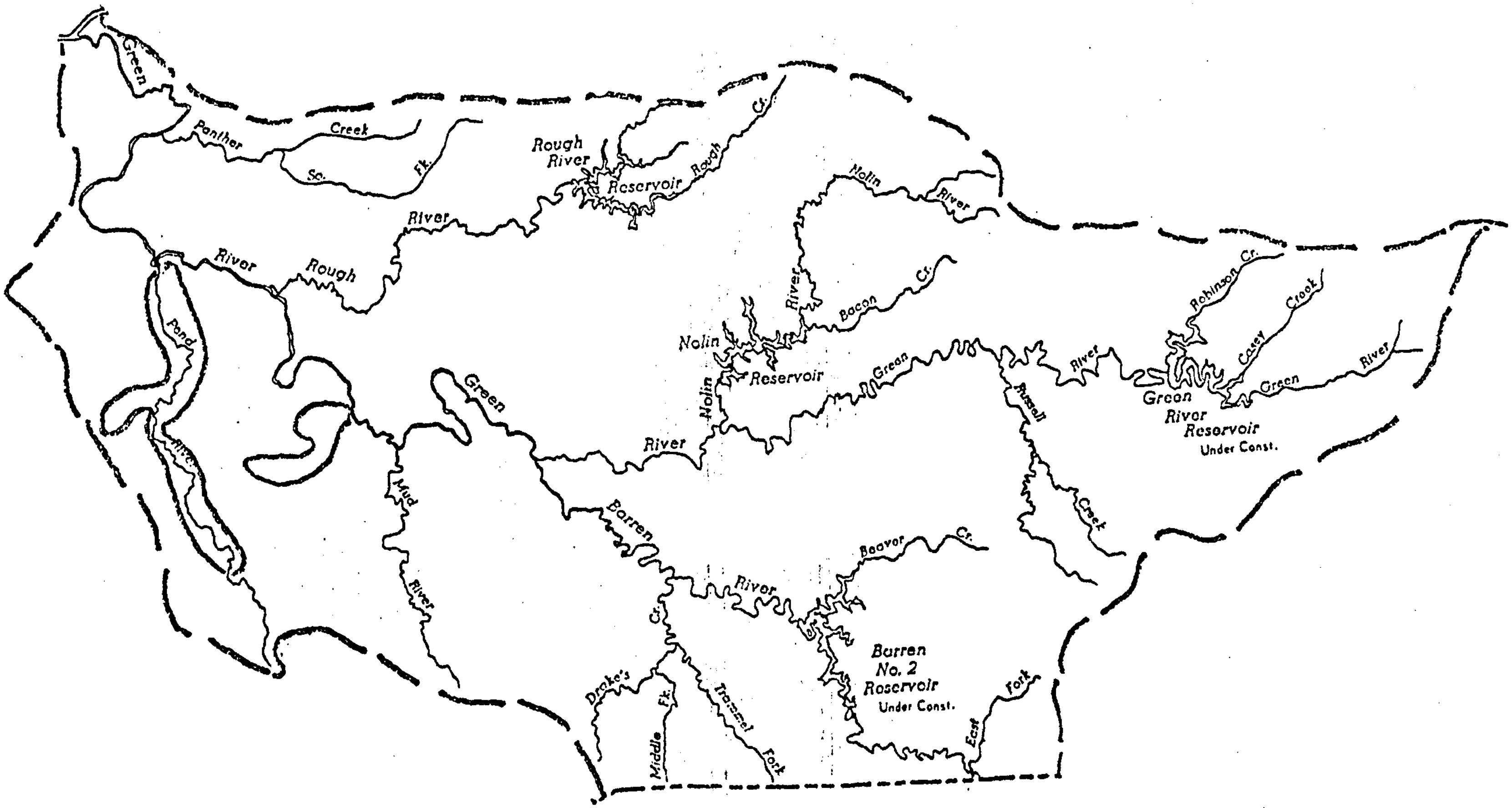
County	City	Surface Public	Surface Industrial	Ground Public	Ground Industrial
Simpson	Franklin	709,000	382,000		
Taylor	Campbellsville Res. and Creek	600,000	900,000		
	Tennessee Gas Piping		183,000	4,000	
Todd					
Warren	Bowling Green	5,230,000	922,000		
	Beech Bend			10,000	
	Warren C.W.D.			131,000	
	Pet Milk				460,000
	Smiths Grove			55,000	600
Webster	Dixon	65,000			
	Sebree			76,000	1,000
	Texas Gas (Slaughters)				44,500
	Slaughters	44,000			
		14,700,000	9,800,000	3,770,000	777,000

Source: Kentucky Department for Natural Resources and Environmental Protection
Division of Water Resources

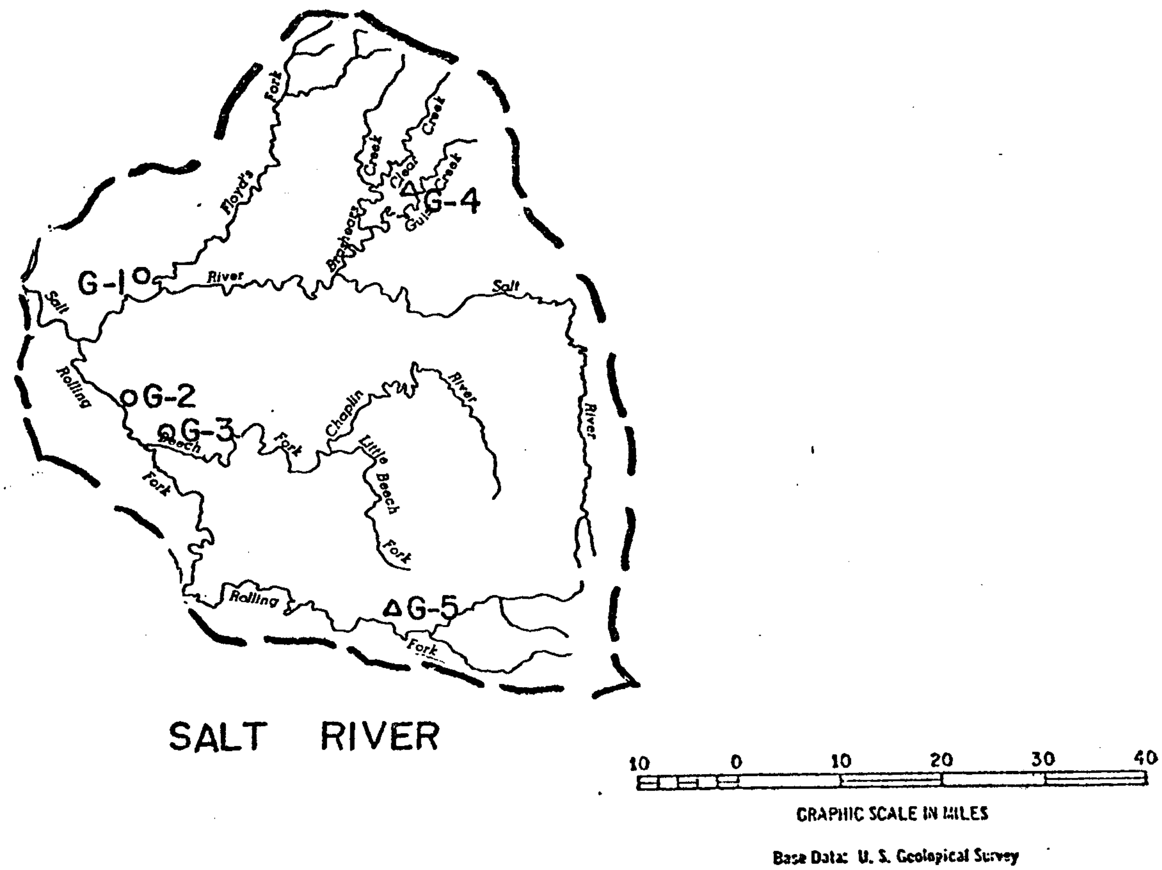
Groundwater Availability in Kentucky



STREAMS CONTINUOUSLY AFFECTED by MINE DRAINAGE



f-21


Floyd's Fork
Creek
Clear
Creek
Brashears
Guist Creek
G-4
G-1
River
Salt
Salt
Rolling
G-2
G-3
Beech
Fork
Chaplin
Fork
River
Little Beech Fork
River
Rolling
G-5
Fork
SALT RIVER
10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

THE SALT RIVER BASIN

The Salt River Basin is the most centrally located basin in Kentucky. It extends 70 miles into Kentucky through rolling farmland and is as wide as it is long. The water quality in this basin is influenced by dry season low flow, excessive erosion, and by the largest population center in Kentucky, Louisville, being partly located within this basin.

The first section of this report will provide a basin description covering both physical and population characteristics. The second section will analyze the water quality considering its causes and effects.

I. Basin Description

A. Geography

The Salt River flows into the Ohio River 352 miles above the mouth of of the Ohio River. The city of West Point at the mouth of the Salt River is 23 miles downstream of Louisville.

The Salt River drains 2,932 square miles of rolling farmland in central Kentucky. This drainage basin contains all or part of the following counties: Bullitt, Jefferson, Oldham, Henry, Shelby, Anderson, Mercer, Boyle, Casey, Marion, Taylor, Larue, Hardin, Nelson, Washington, and Spencer. In the Salt River Basin, there are five sub-basins with an area over 200 square miles. Beech Fork has approximately 750 square miles, Brashears Creek, Floyds Fork, and the Chaplin River all drain about 270 square miles, and the Rolling Fork drains 145 square miles.

B. Topography

The basin lies wholly within the Bluegrass Region which has a hilly to gently rolling topography from east to west with an area of "Knobs" in the northwestern section around the Fort Knox military reservation. This basin is drained by three major streams. These are the Salt River, the Rolling Fork and Beach Fork. The slope of the Salt River is 5.0 feet per mile (ft./mi.).

The slope of Rolling Fork averages 6 ft./mi. and the slope of the Beach Fork is 4 ft./mi.

The average slope of the major tributaries are Brashears Creek, 6 ft./mi., Chaplin River, 6.5 ft./mi., and Floyds Fork, 7 ft./mi. The elevation in this basin varies from 380 to 1,140 feet above sea level.

Slope, up to ten ft./mi., has a direct effect on the reaeration of a stream. With slopes from 0-2 ft./mi., the reaeration is low. Slopes from 3-6 ft./mi. give a medium reaeration while slopes of 7-10 ft./mi. give a high reaeration. These stream slopes provide moderate to good reaeration of the streams.

C. Geology

The base parent materials in this basin are limestone and dolomite, slate and shale. The limestone and dolomite through solution impart hardness to water and give rise to a bicarbonate type of hardness.

The groundwater availability in the Salt River Basin is low. Wells which yeild 100 gallons per minute (g.p.m.) are rare, the majority of the wells produce 50 g.p.m. or less. This limited availability of groundwater and the "Knob" topography are factors causing extremely low flow during the dry months of the year.

D. Hydrology

The stream flow in the Salt River Basin was selected at four gauging stations. The stations are (1) at Boston on the Rolling Fork, (2) at Bardstown on the Beach Fork, (3) Fisherville on Floyds Fork, and (4) at Shepherdsville on the Salt River.

For these stations, the period of record, drainage area, average flow, maximum flow, minimum flow, and the seven day ten year low flows are shown in Table G-6.

Presently, there are no major impoundages in the Salt River to provide for low flow augmentation. The Corps of Engineers has been authorized to construct the Taylorsville Reservoir which will provide low flow augmentation of 60 cfs.

The Salt River at Shepherdsville is very flashy as shown in comparison of the average flow to the maximum. The ratio of average to maximum is 52. Most of the streams at some time of the year have zero flow. The low flow contributes to problems with organic waste loads and sediment.

E. Population

There are 507,232 people in this basin (see Table G-[illegible]). The SMSA of Louisville accounts for sixty-four per cent of the population. This portion of Louisville (Jefferson County) is located in the Pond Creek and Floyds Fork Sub-basins. Louisville has completed a 201 Facility Plan and is developing a 208 area wide waste water management plan. As the 201 plan is implemented, the effect of the 250 discharge into Pond Creek and Floyds Fork will be eliminated with the initial interceptors planned for completion in 1977 and all discharges eliminated by 1985. Roughly seven per cent of the population is located in Hardin County at Fort Knox. The rest of the population is located in small towns and rural populaton throughout the basin. There are eight towns (13,679 people who do not have sewers and these represent possible sources of pollution from septic tanks and other inadequate treatment devices.

TABLE G-6

SURFACE WATER RECORDS FOR THE SALT RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Salt River at Shepherdsville	37 yr.	1,197 sq.mi.	1,551 cfs, 1.3cfs*/sq.mi.	78,200 cfs, 65cfs/sq.mi.	0 cfs	0.6 cfs
	wtr/yr 1975		2,430 cfs, 2.0cfs/sq.mi.	37,700 cfs, 31cfs/sq.mi.	3.6 cfs, 0.0cfs/sq.mi.	
Floyds Fork at Fisherville	31 yr.	138 sq.mi.	173 cfs, 1.3cfs/sq.mi.	28,500 cfs, 206cf/sq.mi.	0 cfs	0 cfs
	wtr/yr 1975		294 cfs, 2.1cfs/sq.mi.	8,890 cfs, 64cfs/sq.mi.	0 cfs	
Rolling Fork near Boston	37 yr	1,299 sq.mi.	1,747 cfs, 1.3cfs/sq.mi.	50,500 cfs, 39cfs/sq.mi.	0.4 cfs, 0.0cfs/sq.mi.	1.7 cfs
	wtr/yr 1975		2,478 cfs, 1.9cfs/sq.mi.	30,800 cfs, 24cfs/sq.mi.	21 cfs, 0.0cfs/sq.mi.	
Beech Fork at Bardstown	wtr/yr 1975**	669 sq.mi.		26,600 cfs, 40cfs/sq.mi.		0.2 cfs

* Cubic feet per second

** Operated as a continuous-record gaging station 1939-74, and as a crest-stage partial-record station since 1975.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

In this section of the report the actual water quality in the Salt River Basin will be examined, along with some of the major factors involved. The major water uses in the basin are also presented.

A. A Description of Sampling Stations

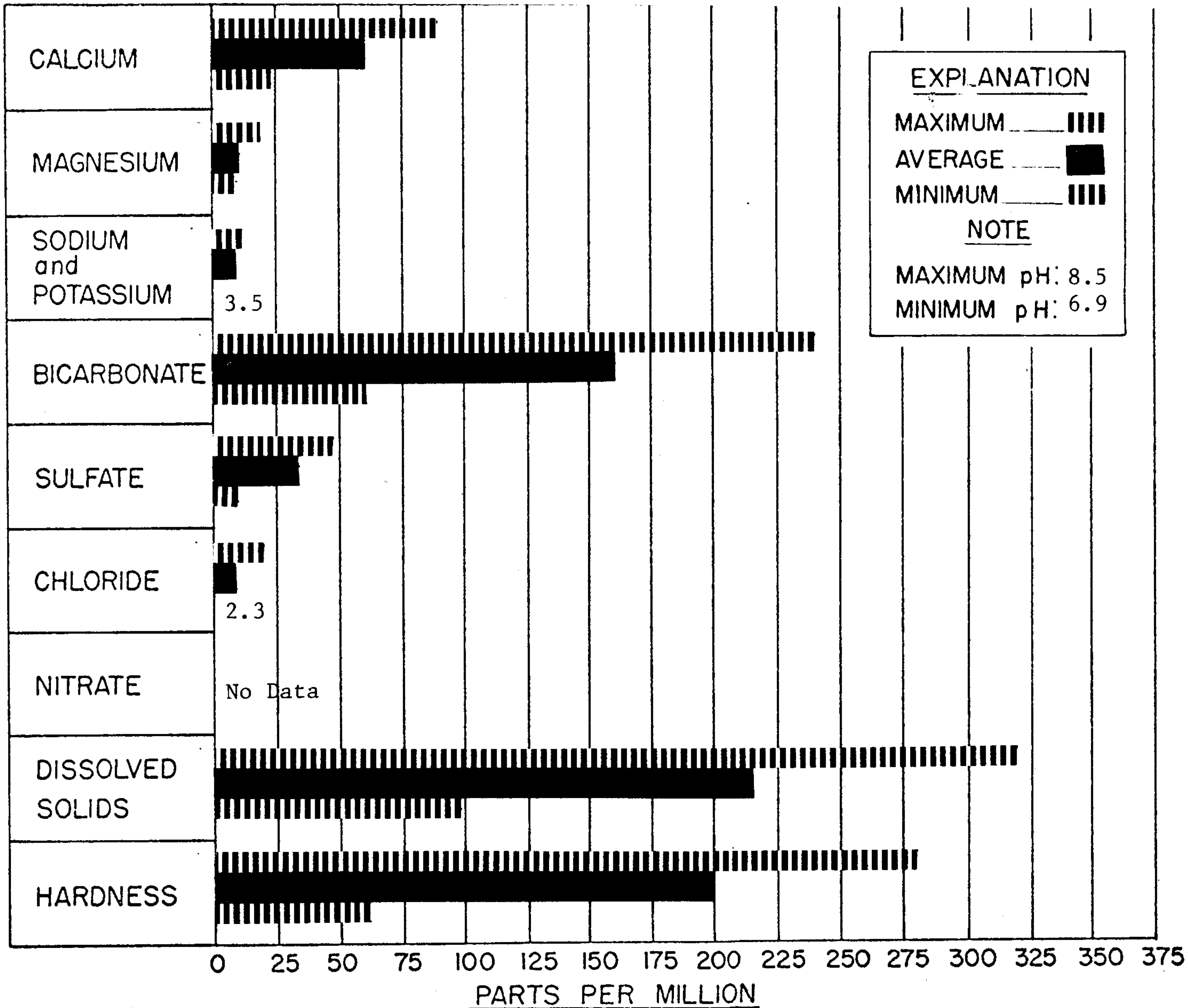
There is one station in this basin with sufficient data to describe water quality. It is located at Shepherdsville, Kentucky, 23 miles upstream from the mouth of the Salt River with drainage basin area of 1,200 sq. mi. or 41 per cent of the basin.

This station was chosen due to the location and length of record. It is believed that the water quality measured at this station is representative of the water quality in most of the surface streams in the basin.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts.

In the Salt River Basin, there is a high bicarbonate ion content giving the water a high bicarbonate hardness. This is due to the limestone bedrock of the area. In all other respects the quality of the surface water is considered to be excellent. The graph of water quality indicates the variation from the



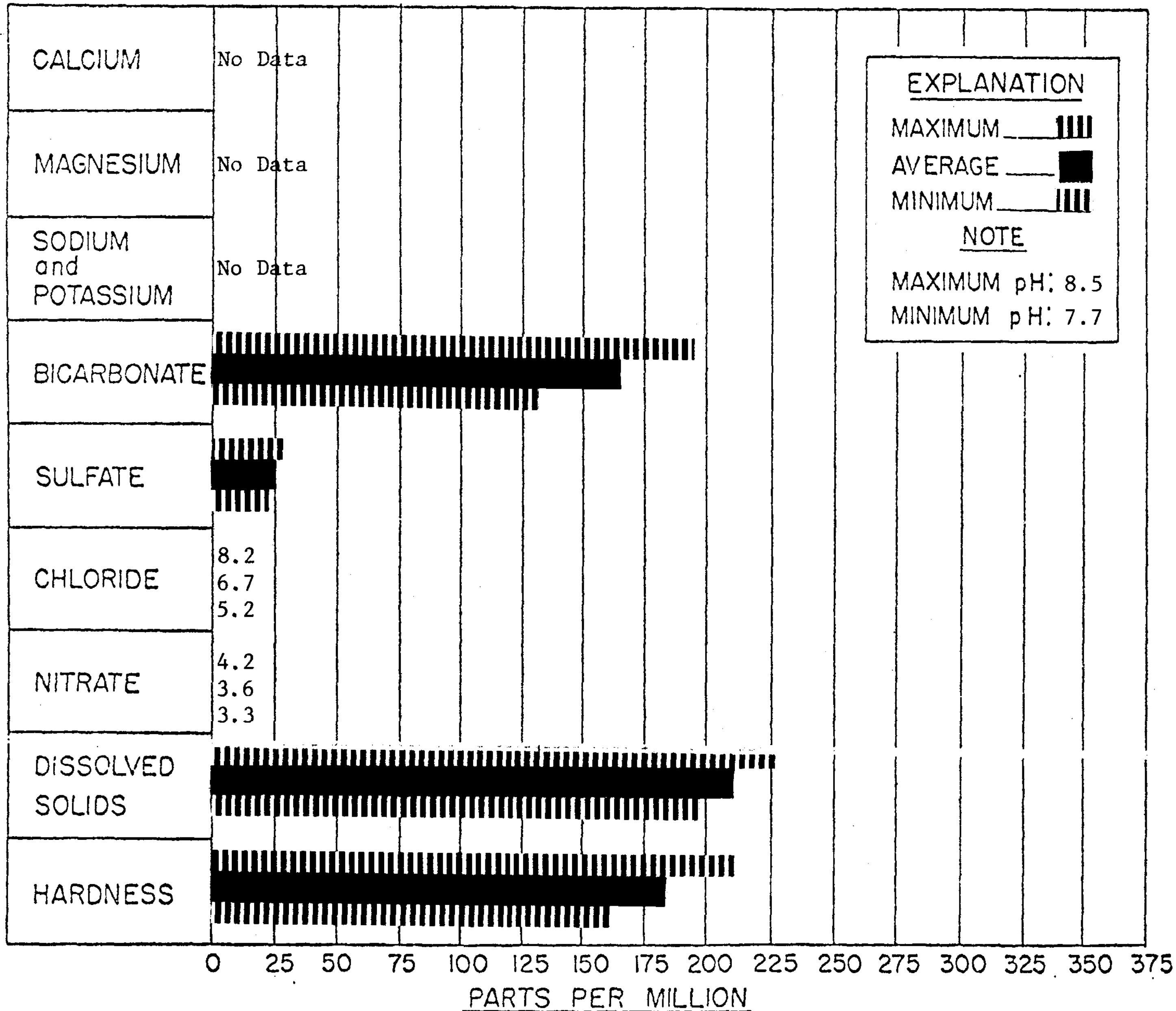
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE G-1

Salt River

Shepherdsville

11-65 to 11-74



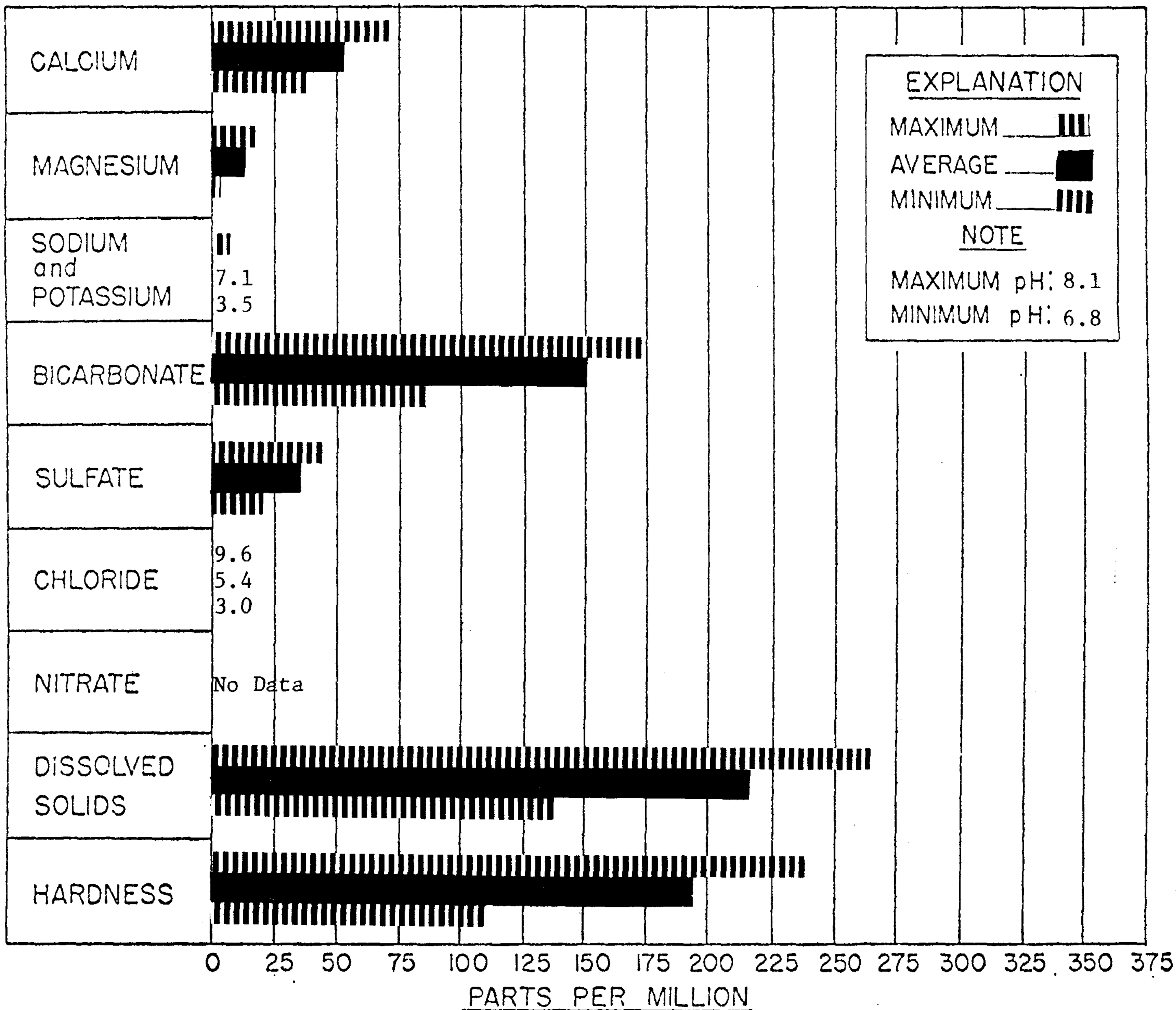
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE G-2

Rolling Fork

Boston

10-70 to 9-72



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE G-3

Rolling Fork

Lebanon Junction

10-74 to 12-75

average is low and, therefore, uniformity of water quality allows stable operation of water supply treatment plant and industry water usage is enhanced.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

Trace chemicals in the surface water of the Salt River Basin in Kentucky were measured as being within Kentucky-Federal Water Quality Standards.

D. Waste Load Effects on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such a waste load is considered to have an effect upon water quality when they cause the dissolved oxygen (D.O.) concentration to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Based on a model developed for the Kentucky Continuing Planning Process for River Basin Management Planning, 596 miles of streams in the basin that receive waste discharges were evaluated.. On the basis of present treatment levels and once on 10 year 7 day low flows the model shows 160 stream miles (28 per cent of the miles modeled) are affected by discharges.

The types of facilities affecting the streams and the length affected are 61 miles (11 per cent) by municipal discharges; 8 miles (1.7 per cent) by industrial discharges, and 91 miles (15 per cent) by other discharges. A miscellaneous discharge is one that is privately owned, eg. subdivisions, schools, etc. (See Table G-5)

E. Non-Point Source Effects

The primary non-point source of pollution in the Salt River is from soil erosion. The sediment pollution comes from field and stream bank erosion. In 1973 about 100 sq. mi. associated with agricultural crop land had high erosion rates and there are approximately 50 miles of streambanks that are a critical sediment source.

F. Water Uses in the Basin

Water uses in the basin are public and industrial, recreation, fish and wildlife, and agricultural. The total public and industrial usage in the Salt River Basin is 10 million gallons per day (m.g.d.) from surface water at 9.6 m.g.d. and groundwater at 0.4 m.g.d. The industrial usage is 5.5 m.g.d., (groundwater 0.1 m.g.d., surface water 5.4 m.g.d.) and the public usage is 4.5 m.g.d., (groundwater 0.4 m.g.d. and surface water 4.1 m.g.d.). Water withdrawal during periods of low flow is not a problem since during periods of low flow the water is withdrawn from reservoirs.

There are no large commercial water recreation sites in this basin.

It is generally understood that the Salt River Basin is good in sport fishing.

The Kentucky Department of Fish and Wildlife Resources is studying the sport fishing in this basin and a report will be published in the next two years.

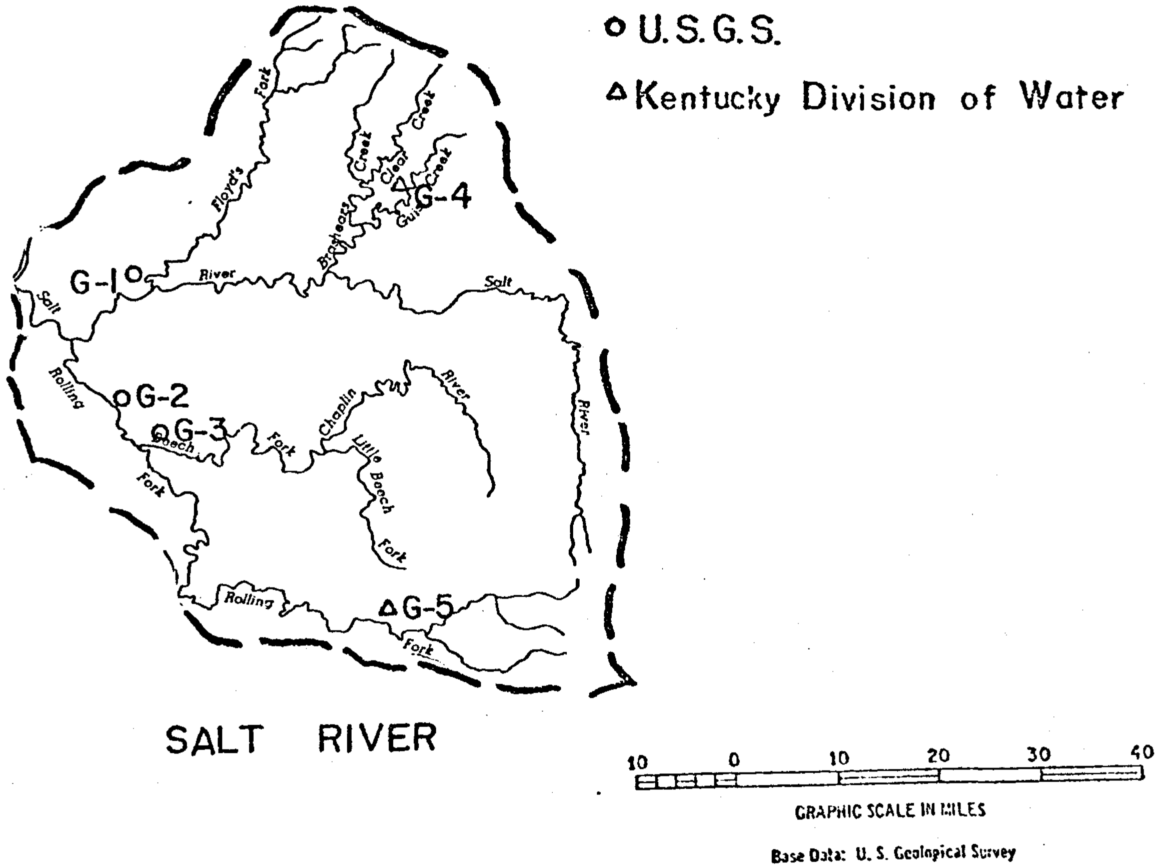
G. Water Quality Changes

Sedimentation data that was collected in the period of 1948 to 1954 indicated that the Salt River Basin had the largest sediment load of any basin in Kentucky. The effects of agricultural runoff and logging operations in relation to the topography created a difficult control problem from these sources of sediment load. Continued effort by the U.S.D.A. SCS by encouraging proper soil utilization should assist in controlling the sediment load problem.

The problem associated with municipal waste discharge into Pond Creek and Floyds Fork will be corrected in a comparatively short time by intercepting the waste and conveying this waste to a treatment facility to be located on the Ohio River. Therefore, the expected changes in water quality are for improvement in both sediment load and from maintenance of D.O. levels at or above the level of the State-Federal Water Quality Standards.

III. Summary

The general chemical and trace water quality in Kentucky's Salt River Basin has been shown to be of high quality. There are problems, however, related to other aspects of water quality in the basin that require attention and action to be corrected. Severe soil erosion from farming practices presents a major problem with excessive sediment in the water. Treated wastes discharged from municipal, independent and industrial sources effect the water quality of the basin's streams. Upgrading the treatment facility and improvement in operation and maintenance of waste treatment facilities is needed. A program of operator licensing and education to improve operation and maintenance is a significant part of the Division of Water Quality operations.



SALT RIVER

STATION KEY

G-1 SALT RIVER AT SHEPHERDSVILLE
G-2 ROLLING FORK AT LEBANON JUNCTION
G-3 ROLLING FORK AT BOSTON
G-4 GUIST CREEK AT SHELBYVILLE
G-5 ROLLING FORK AT LEBANON

TABLE G-2

Population in the Salt River Basin

County	City		Urban Population in Basin	Total Population in Basin	Area (sq. mi.)
Casey				4,150	94
Taylor				100	28
Larue				2,600	89
Hardin				49,000	140
	Fort Knox		37,608		
	Radcliff		7,881		
		Total	45,489		
Bullitt				26,090	300
	Mt. Washington		2,020		
Jefferson				323,000	220
	Louisville		79,919		
	Seneca Gardens		822		
	Strathmore		1,004		
	Jeffersontown		9,701		
	Fern Creek		6,000		
	Beuchel		9,000		
	Audubon Park		1,862		
	Newburg		4,000		
	Okolona		17,643		
	Prairie Village		3,000		
	Fairdale		2,500		
	Glengary		1,500		
	Valley		3,500		
	Medora		300		
		Total	166,882		
Oldham				5,750	64
	Crestwood		900		
	Pewee Valley		950		
			1,850		
Henry				1,087	14
	Pleasureville		747		
Shelby				15,900	314
	Shelbyville		4,182		
	Simpsonville		628		
	Veachland		700		
		Total	5,510		
Anderson				7,500	140
	Lawrenceburg		3,579		
	Stringtown		300		
			3,879		
Mercer				11,800	150
	Harrodsburg		6,741		
	Salvisa		350		
			7,091		

County	City		Urban Population in Basin	Total Population in Basin	Area (sq. mi.)
Boyle				4,600	100
	Mitchellsburg		500		
	Perryville		730		
		Total	1,230		
Marion					
	Bradfordsville		338	16,700	343
Nelson				23,480	437
	New Haven		977		
	Bardstown		5,816		
		Total	6,793		
Washington				10,730	307
	Loretto		985		
	Springfield		2,961		
			3,946		
Spencer				5,492	192
	Taylorsville		897		
		TOTAL	245,925	507,232	2,932

Source: 1970 U. S. Census as reported in the Rand McNally "Standard Reference Map and Guide of Kentucky"

TABLE G-3

Water Quality Data for Salt River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
STORET #00400	pH Specific Units, Ky. Std. 6 LT pH LT 9						
Salt R., Shepherdsville	75/02/14	75/02/14	7.2			1	
USGS #03298500	70/04/03	72/07/26	7.7	8.4	7.0	9	.444
	65/11/09	74/11/-	7.8	8.5	6.9	39	.5
Rolling Fk., Nr Leb Jct.	75/01/09	75/12/02	7.2	7.7	6.8	12	.277
USGS #03301630	74/10/08	74/12/09	7.5	8.1	7.2	3	.493
Rolling Fk., Nr Boston	70/10/05	72/09/01	8.2	8.5	7.7	3	.416
USGS #03301500							
STORET #00095	Conductivity Micro Mhos, Ky. Std 800 micro mhos						
Salt R., Shepherdsville	75/02/14	75/06/25	410	420	400	2	14.1
	70/04/03	74/06/11	403	537	176	18	81.5
	65/11/09	74/06/-	400	540	170	49	80
Rolling Fk. Nr Leb. Jct.	75/01/09	75/12/02	353	455	230	12	64.2
	74/10/08	74/12/09	395	430	365	3	32.8
Rolling Fk. Nr Boston	70/10/05	72/09/01	363	421	315	3	53.6
STORET # 70300	Residue mg/l Ky. Std. 500 mg/l						
Salt R., Shepherdsville	70/04/03	72/07/26	249	332	114	9	60.2
	65/11/09	72/07/26	248	336	114	37	49.6
	53/12/08	72/07/26	226	336	95	72	48.7
Rolling Fk. Nr Leb. Jct.	75/01/09	75/12/02	211	250	142	12	34.5
	74/10/08	74/12/09	250	266	238	3	14.4
Rolling Fk. Nr Boston	70/10/05	72/09/01	210	226	198	3	14.4
STORET #00410	Alkalinity mg/l, No standard						
Salt R., Shepherdsville	70/04/03	72/07/26	168	241	62	9	47.7
	66/10/19	72/07/26	167	241	62	17	38.3
Rolling Fk. Nr Leb. Jct.	75/01/09	75/12/02	144	182	84	12	29.5
	74/10/08	74/12/09	178	193	169	3	13.1
Rolling Fk. Nr Boston	70/10/05	72/09/01	162	192	130	3	31.0

Table G-3
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS	S
STORET #00900	Hardness mg/l, 0-60 Soft, 61-120 Mod.Hard, 121-181 + Very Hard						
Salt R., Shepherdsville	70/04/03	72/07/26	203	280	80	9	53.3
	65/11/09	72/07/26	206	280	80	37	44.4
Rolling Fk. Nr Leb. Jct.	75/01/09	75/12/02	178	220	110	12	31.1
	74/10/08	74/12/09	217	240	200	3	20.8
Rolling Fk. Nr Leb.Jct.	70/10/05	72/09/01	183	210	160	3	25.2
STORET #00950	Fluoride mg/l, Ky. Std. 1.0 mg/l						
Salt R. Shepherdsville	70/10/05	72/07/26	0.22	0.30	0.20	4	.0500
	65/11/09	72/07/26	0.21	0.30	0.10	8	.0835
Rolling Fk. Nr Leb. Jct.	75/01/09	75/12/02	0.21	0.40	0.00	12	.1084
	74/10/08	74/12/09	0.20	0.20	0.20	3	.0000
Rolling Fk. Nr Boston	70/10/05	72/09/01	0.20	0.20		3	.0000
STORET #00915	Calcium mg/l, No Standard						
Salt R. Shepherdsville	70/04/03	72/07/26	59	90	26	3	32.0
	65/11/09	72/07/26	66	90	26	7	20.0
Rolling Fk. Nr Leb.Jct.	75/01/09	75/12/02	52	63	34	12	8.3
	74/10/08	74/12/09	65	71	60	3	5.7
STORET #00925	Magnesium mg/l, No standard						
Salt R., Shepherdsville	70/04/03	72/07/26	9.2	13.0	3.7	3	4.90
	65/11/09	72/07/26	12.5	18.0	3.7	7	4.45
Rolling Fk.,Nr Leb. Jct.	75/01/09	75/12/02	11.7	15.0	5.8	12	2.61
	74/10/08	74/12/09	13.3	15.0	12.0	3	1.53
STORET #01049	Lead ug/l (micro-grams per liter), Ky. Std. 50 ug/l						
Salt R., Shepherdsville	75/02/14	75/06/25	2.3	3.0	1.0	3	1.15
	74/03/26	74/09/05	3.7	9.0	0.0	6	3.50
Rolling Fk. Nr Leb. Jct.	75/04/08	75/10/07	4.3	10.0	0.0	3	5.13
	74/10/08	74/10/08	6.0			1	

Table G-3
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #01000	Arsenic ug/l, Ky. Std. 50 ug/l						
Salt R., Shepherdsville	75/02/14	75/06/25	0.0	0.0	0.0	3	0.0
	74/03/26	74/09/05	2.5	4.0	1.0	6	1.38
Rolling Fk. Nr Leb Jct.	75/01/09	75/10/07	0.5	1.0	0.0	4	0.58
	74/10/08	74/10/08	1.0			1	
STORET #01025	Cadmium ug/l, Ky. Std. 100 ug/l						
Salt R., Shepherdsville	75/02/14	75/06/25	0.0	0.0	0.0	3	0.0
	74/03/26	74/09/05	0.3	1.0	0.0	6	0.52
Rolling Fk. Nr Leb Jct.	75/01/09	75/10/07	3.0	7.0	0.0	4	3.16
	74/10/08	74/10/08	1.0			1	
STORET #01030	Chromium ug/l, Ky. Std. 50 ug/l						
Salt R., Shephardsville	75/02/14	75/06/25	1.0	3.0	0.0	3	1.73
	74/03/26	74/09/05	0.8	3.0	0.0	6	1.17
Rolling Fk. Nr Leb Jct.	75/01/09	75/10/07	0.5	2.0	0.0	4	1.00
	74/10/08	74/10/08	0.0			1	
STORET #00080	Color Platinum Cobalt Units, Prop. EPA Std. 75 Units.						
Salt R., Shepherdsville	70/04/03	72/07/26	52	140	5	3	76.5
	65/11/09	72/07/26	26	140	1	7	50.3
STORET #00930	Sodium mg/l, No Standard						
Salt R., Shepherdsville	70/04/03	72/07/26	6.8	12.0	2.0	3	5.01
	65/11/09	72/07/26	6.6	12.0	2.0	7	2.95
Rolling Fk., Nr Leb. Jct.	75/01/09	75/12/02	4.4	7.5	2.3	12	1.58
	74/10/08	74/12/09	4.6	5.5	3.8	3	0.86
STORET #00935	Potassium mg/l, No Standard						
Salt R., Shepherdsville	70/04/03	72/07/26	3.1	4.0	2.3	3	0.85
	65/11/09	72/07/26	2.8	4.0	1.5	7	0.89
Rolling Fk.,Nr Leb. Jct.	75/01/09	75/12/02	2.5	3.7	1.2	12	0.83
	74/10/08	74/12/09	3.5	4.0	2.6	3	0.81

Table G - 4

City Population and Facility Grant Status in the Salt River Basin in Kentucky

County	City	Population	Project Type	Comments
Anderson	Alton	160	II	Pending
	Lawrenceburg	3,579	I	Underway
Bullitt	Lebanon Junction	1,571	I	Pending
Henry	Pleasureville	747	I	Underway
Jefferson	Jeffersontown	9,701	II & III	Pending
	Okalona	17,643	II	Underway
			III	Pending
Marion	Lebanon	5,528	I	Underway
Mercer	Harrodsburg	6,741	I	Underway
Nelson	Bardstown	5,816	I	Underway
Shelby	Shelbyville	4,182	I	Underway
	Simpsonville	628	I	Underway
Washington	Springfield	2,761	I	Underway

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a comple and original system.

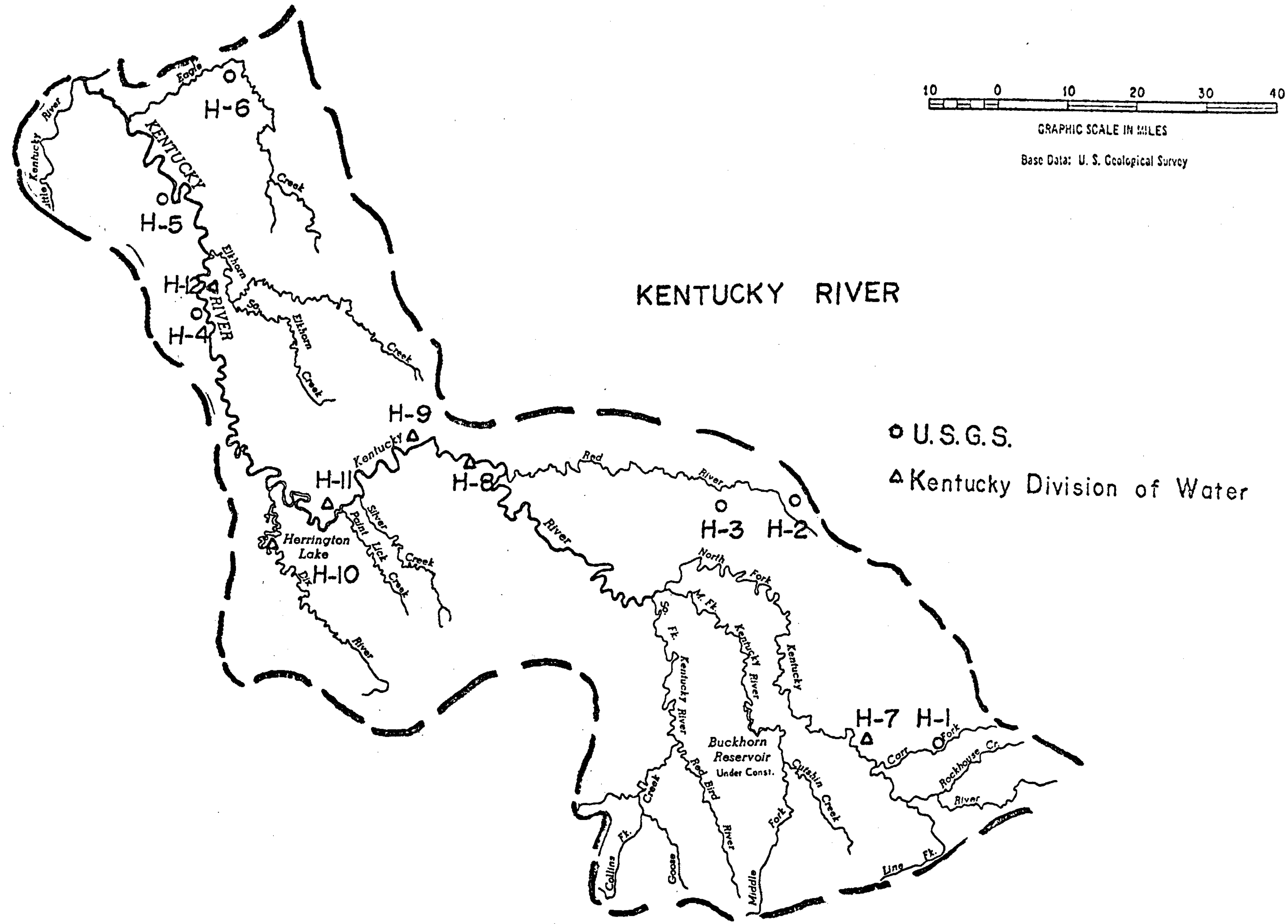
The source of this information was the 1970 U. S. Census and the FY 75 construction grants list for Kentucky.

TABLE G-5

Organic Loads Affecting Streams in the Salt River Basin

Length of streams to which treated organic loads are discharges		596 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		160 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		
	Municipal Discharges	66 miles
	Industrial Discharges	8 miles
	Other Discharges	91 miles

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q_{10-7}) low flow.


KENTUCKY RIVER
10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey
U.S.G.S.
Kentucky Division of Water
H-1
H-2
H-3
H-4
H-5
H-6
H-7
H-8
H-9
H-10
H-11
H-12
KENTUCKY RIVER
Little Kentucky River
Eagle Creek
Elkhorn Creek
So. Elkhorn Creek
Kentucky River
Red River
Silver Creek
Paint Lick Creek
Herrington Lake
Dix River
North Fork Kentucky
M. Fk. Kentucky River
So. Fk. Kentucky River
Buckhorn Reservoir
Under Const.
Red Bird River
Middle Fork
Cutshin Creek
Goose Creek
Collins Fk.
Carr Fork
Rockhouse Cr.
River
Line Fk.

THE KENTUCKY RIVER BASIN

This report is basically divided into two main sections, the first section being a description of the basin and the second section dealing with the quality of the water in the basin.

The first section is entitled "Basin Description" and describes the geography, topography, geology, hydrology and population characteristics within the Kentucky River Basin.

The second section of the report is entitled "Basin Water Quality" and describes the quality of the water with respect to general chemical, trace chemical, waste load effects, non-point source effects, uses, and changes.

I. A Description of the Kentucky River Basin

A. Geography

In an effort to better describe the Kentucky River Basin it will be divided into two sections. The first section (hereinafter referred to as the "Headwater Section") begins at the headwaters and ends at the City of Irvine and includes the three major forks of the river and 37 miles of its main stem. The remainder of the basin (hereinafter referred to as the "Bluegrass Section") will further be divided into inner and outer sections. The main stem of the Kentucky River is 255.5 miles long from it's mouth to the confluence of the North, Middle and South Forks.

The Kentucky River Basin lies wholly within the State of Kentucky and the river flows in a northwesterly direction. It begins in southeastern Kentucky, flows through the central part of the state and empties into the Ohio River at mile point 435.6 in North Central Kentucky.

The total area of the basin is 7,033 sq. mi. and contains eight sub-basins with areas of over two hundred sq. mi.. (See Table H-1) The basin contains, either wholly or partially, 36 of the 120 counties in the State. (See Table H-2)

B. Topography

The Headwater Section is a mountainous area and is heavily mined for coal. Therefore, the water has a considerable sulfate content and is slightly acidic in the immediate coal mining areas. The average slope of the tributaries in this section ranges from 3 ft./mi. to 7.2 ft./mi. which are moderate slopes and it can therefore be said that the waste load assimulation capacity of the tributaries in this section is moderate. The average slope of the main stem of the river in this section is approximately 0.9 ft./mi. which is a low slope for reaeration.

The maximum elevations of the tributaries in this section range from 760 feet to 1,250 feet mean sea level (m.s.l.). It should be noted that water will hold about 2 per cent less dissolved oxygen for every 500 feet in elevation above sea level. Therefore, the dissolved oxygen capacity of these streams is retarded by approximately 4 per cent.

The Bluegrass Section lies in north-central Kentucky and is a structurally high but physiographically level area. The average slope of the tributaries in this section ranges from approximately 3 feet per mile to 32 feet per mile which are moderate to high and it can therefore be said that the waste load assimilation capacity of the tributaries in this section are moderate to high. The average slope of the main stem of the river in this section is approximately 0.7 ft./mi.

The maximum elevations of the tributaries in this section range from 710 feet to 950 feet m.s.l. and therefore the dissolved oxygen capacity of these streams is retarded by approximately 3 per cent. (For more detailed information regarding slopes and elevations see Table H-3)

C. Geology

For the purposes of this report the most significant geological feature in the Headwater Section is the coal resources. Due to the mining activities including the stripping, washing, and loading of coal, there is a great amount of exposed coal in this area. The runoff is rapid and carries a considerable amount of solids to the streams. There are also thin beds of limestone in this area which contribute to the hardness of the water. Because of greater relief and the resulting more rapid runoff of surface water and drainage of groundwater from exposed strata, groundwater is not available in adequate amounts for water supply. Groundwater supplies diminish in dry weather owing to the paucity of groundwater storage.

The Bluegrass Section can be divided into inner and outer sections with regards to geology, the inner bluegrass being underlain by thick, pure limestone and the outer bluegrass by outward dipping thin beds of limestone and shale. The limestone of the inner bluegrass, though thick and soluble, contains shaly zones which are important because they limit the circulation of water and the development of permeable zones. In the outer bluegrass the conditions are even less favorable because the limestone beds are thinner and there is more inner bedded shale. Limestone that underlies shale will rarely yield much water except near streams that have cut through the shale. The only wells in bedrock that produce more than 100 gallons per minute are in thick limestone in the inner bluegrass. Nearly all successful wells in bedrock are less than 100 feet deep. In the bluegrass region as a whole the groundwater is hard to very hard. About one-eighth of the existing wells are reported to yield water containing excessive sodium and chloride, and about one-fifth yield water containing noticeable amounts of hydrogen sulfide.

D. Hydrology

The Kentucky River has fourteen dams (See Table H-8) in it which restrict the flow and cause a decrease in reaeration rates, therefore causing the dissolved oxygen content to be reduced when an organic load is imposed on the stream. Furthermore, the slow moving water allows suspended solids to settle causing sludge deposits which impose a demand on dissolved oxygen and can hamper navigation unless removed.

There are two water withdrawals in the basin that are significant to water quality. The City of Lexington withdraws from the Kentucky River but discharges to tributaries which enter the river below Lock 8, and the City of Winchester withdraws from the Kentucky River but discharges to another basin. The City of Winchester withdraws approximately 1.5 MGD and the City of Lexington withdraws approximately 28 MGD. These two withdrawals are not put back in the river above Lock 8 near Frankfort and therefore reduce the once in seven day, ten year low flow at the Lock by the total 29,500,000 gallons per day or approximately by 20 per cent. This reduced low flow can affect the waste load allocation and subsequent treatment levels required for the cities of Richmond and Berea.

The City of Lawrenceburg also withdraws from the Kentucky River and discharges into another basin but this withdrawal has no significant impact on water quality.

The average normal flow of the Kentucky River at Locks 14, 10, and 4 are 3,369 cubic feet per second, 5,279 cubic feet per second, and 7,199 cubic feet per second respectively. The average yield of the basin is 1.3 cubic feet per second per square mile throughout the main stem of the river. Table H-4 expands on the flow records.

TABLE H- 4

SURFACE WATER RECORDS FOR THE KENTUCKY RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10 yr. LOW FLOW
N. Fork of KY. River at Hazard	35 yrs.	466 sq.mi.	585 cfs, 1.3cfs*/sq.mi.	47,800 cfs, 103cfs/sq.mi.	Not determined	93 cfs
	wtr/yr 1975		1,042 cfs, 2.2 cfs/sq.mi.	21,500 cfs, 46cfs/sq.mi.	8.7 cfs, 0.0cfs/sq.mi.	
Lock 14 near Heidelberg **	43 yr.	2,657 sq.mi.	3,369 cfs, 1.3cfs/sq.mi.	120,000 cfs, 45cfs/sq.mi.	4.0 cfs, 0.0cfs/sq.mi.	120 cfs
	wtr/yr 1975		6,007 cfs, 2.3cfs/sq.mi.	80,600 cfs, 30cfs/sq.mi.	199 cfs, 0.1cfs/sq.mi.	
Lock 10 near Wincester **	68 yr.	3,955 sq.mi.	5,279 cfs, 1.3cfs/sq.mi.	92,400 cfs, 23cfs/sq.mi.	10 cfs, 0.0cfs/sq.mi.	160 cfs
	wtr/yr 1975		8,382 cfs, 2.1cfs/sq.mi.	71,500 cfs, 18cfs/sq.mi.	175 cfs, 0.0cfs/sq.mi.	
Lock 4 near Frankfort ***	50 yr.	5,412 sq.mi.	7,199 cfs, 1.3cfs/sq.mi.	115,000 cfs, 21cfs/sq.mi.	Not determined	270 cfs
	wtr/yr 1975		10,890 cfs, 2.0cfs/sq.mi.	77,700 cfs, 14cfs/sq.mi.	359 cfs, 0.1cfs/sq.mi.	

TABLE H-4
Continued

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Elkhorn Creek near Frankfort	38 yr.	473 sq.mi.	612 cfs, $\frac{1.3 cfs}{sq.mi.}$	23,200 cfs, $\frac{49 cfs}{sq.mi.}$	0 cfs	28 cfs****
	wtr/yr 1975		935 cfs, $\frac{2.0 cfs}{sq.mi.}$	12,300 cfs, $\frac{26 cfs}{sq.mi.}$	44 cfs, $\frac{0.1 cfs}{sq.mi.}$	

* Cubic feet per second

** Flow regulated by Buckhorn Lake beginning December, 1960.

*** Flow regulated by Buckhorn Lake since December, 1960, By Herrington Lake since November, 1925, and by a Hydroelectric plant at Lock 7.

**** Low flow contribution from main Lexington Town Branch Plant, 18 MGD (28 cfs).

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

There are fifteen lakes (See Table H-5) located in this basin with a total combined volume of 286,000 acre feet and a total combined surface are of 6,530 acres. The only lakes considered in the Kentucky basin report are those whose volume is greater than 1,000 acre feet or have a surface area greater than 100 acres. Two of these lakes, Buckhorn Lake and Carr Fork Lake, are Federal installations with a combined volume of 28,000 acre feet. The Buckhorn Lake (22,000 acre feet) is regulated to meet flood, recreation, fish and wildlife and low flow augmentation objectives. The low flow augmentation objective aides the stream below the lake during periods of low flow by means of dilution and reaeration. The Carr Fork Lake (6,000 acre feet) has not been in operation long enough to determine its effects upon the stream below it.

E. Population

The total population in the basin is 534,400 with the rural population being 291,200 or 55 per cent of the total population. There are forty-two incorporated cities in the basin representing the remaining 243,200 people. The major concentration of population is in the inner bluegrass region in the adjoining counties of Fayette, Madison, Franklin, Scott and Woodford. These five counties represent 283,900 people or 53 per cent of the total population in the basin. (See Table H-6)

II. Basin Water Quality

A. Description of Sampling Stations

The water quality data presented in the next two sections of this report was collected at six sampling station. Three of these station are located on the main stem of the river at Lock 2 near Lockport, at Lock 4 near Frankfort and at the Lexington water treatment plant near I-75 in southern Fayette County. The other three stations are located on major tributaries thusly: North Fork of the Kentucky River at Hazard having 466 square miles above it, the station on the Red River having 180 square miles above it, the station on the main stem at Lexington having 4,015 square miles above it, the station on Eagle Creek at Flencoe having 430 square miles above it, and the station on the main stem at Lock 4 having 5,412 square miles above it. The summary of the raw water quality data is in Table H-9.

The station on the North Fork at Hazard was purposely chosen to represent water quality data in a coal mining area. The other four stations are more indicative of the general water quality in the Kentucky River Basin.

B. General Chemical Water Quality

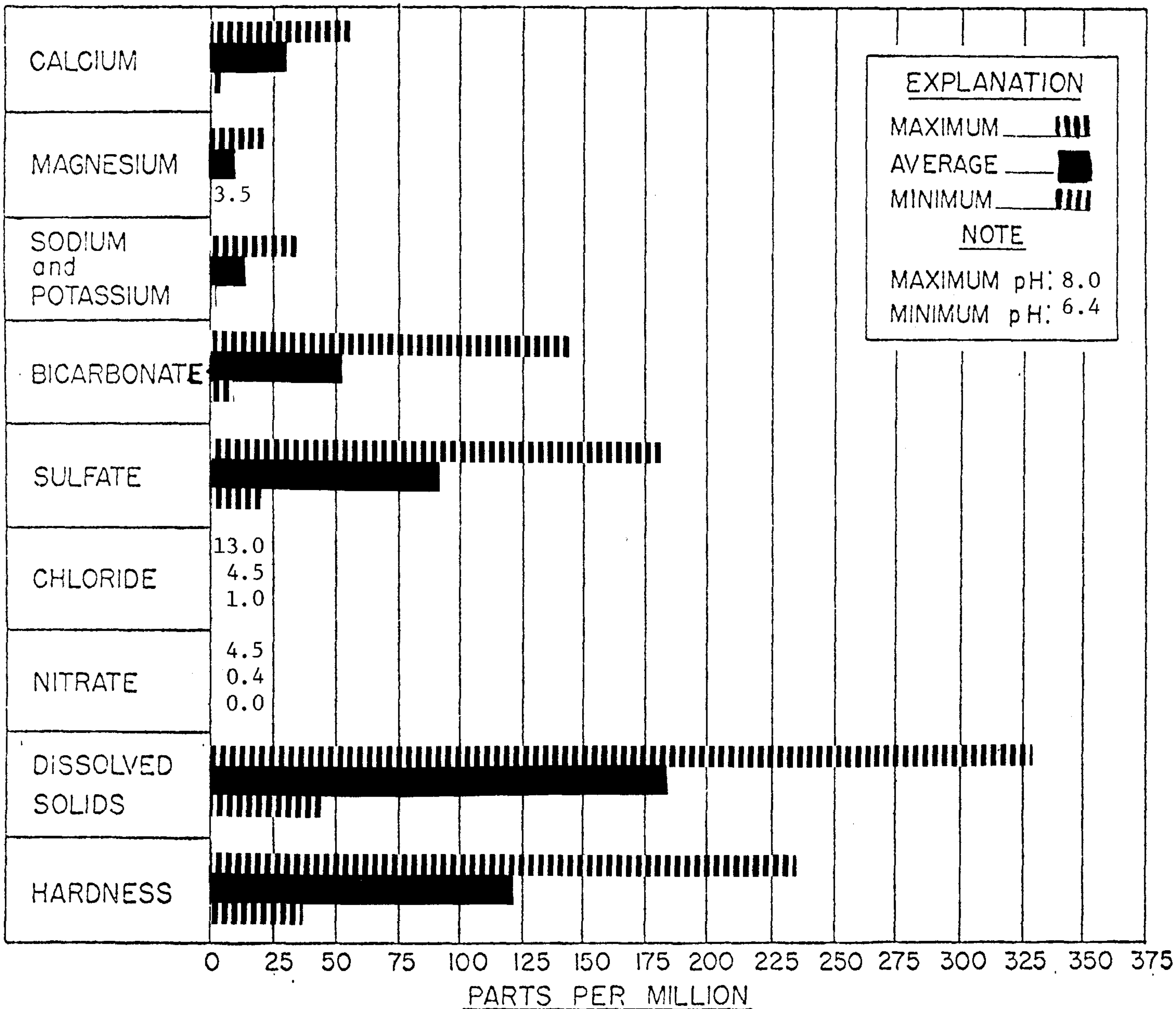
The Chemcial composition of water is best defined by grouping dissolved elements which compose the total dissolved solids, by examining the relationships of groups of chemicals, the type of water whether hard or soft, slaty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristics. The contribution of groundwater, whcih is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicatedwhen the slufate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20 - 25 parts per million as an average value.

The overall water quality for the Kentucky River Basin is represented by the stations at Lock 4 near Frankfort, Red River at Pine Ridge, and Eagle Creek at Glencoe and Red River at Pine Ridge and both demonstrate the water quality for a sensitive stream. This means that water quality parameters have a wide range with respect to the average value.

Reference is made to Figures H-10, H-11 and H-12 which represent data for Eagle Creek at Glencoe for the period of 1-75 to 11-75, 2-73 to 11-74, and 1-62 to 11-74, respectively. Water Quality at Eagle Creek at Glencoe indicates that the water is very hard meaning that the calcium carbonate hardness is greater than 180 mg/l. Water in this sub-basin tends to be periodically acidic. The data indicates that the bicarbonate alkalinity is high providing a good inorganic load buffering capacity in this particular stream. The overall water quality in this sub-basin is good.

Relative to the Eagle Creek Basin, the water quality in the Red River at Pine Ridge has a higher quality as demonstrated by Figures H-4 and H-5. This is indicated by water characterized as soft (calcium carbonate hardness



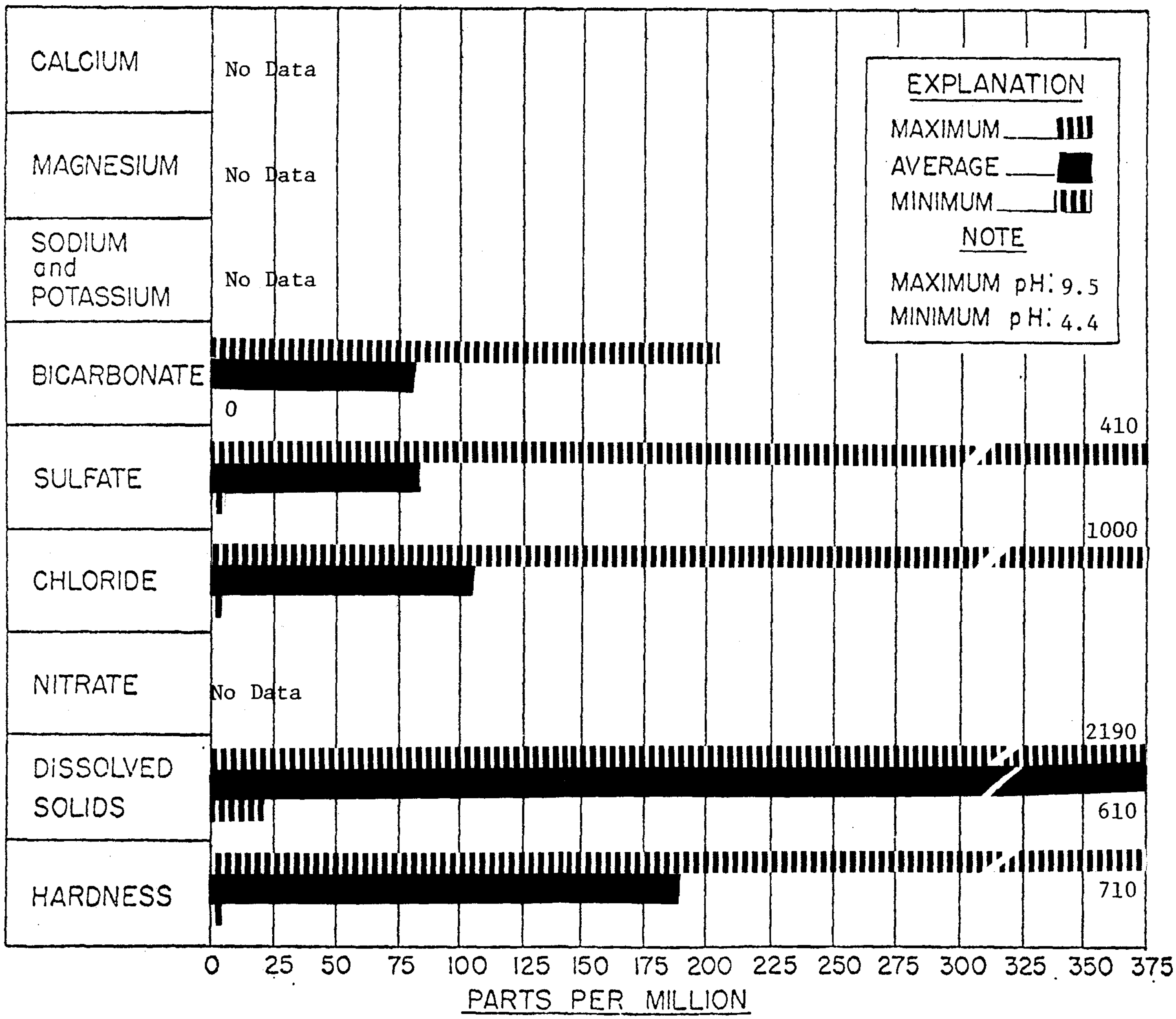
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE H-1

Carr Fork

Sassafras

7-70 to 12-74



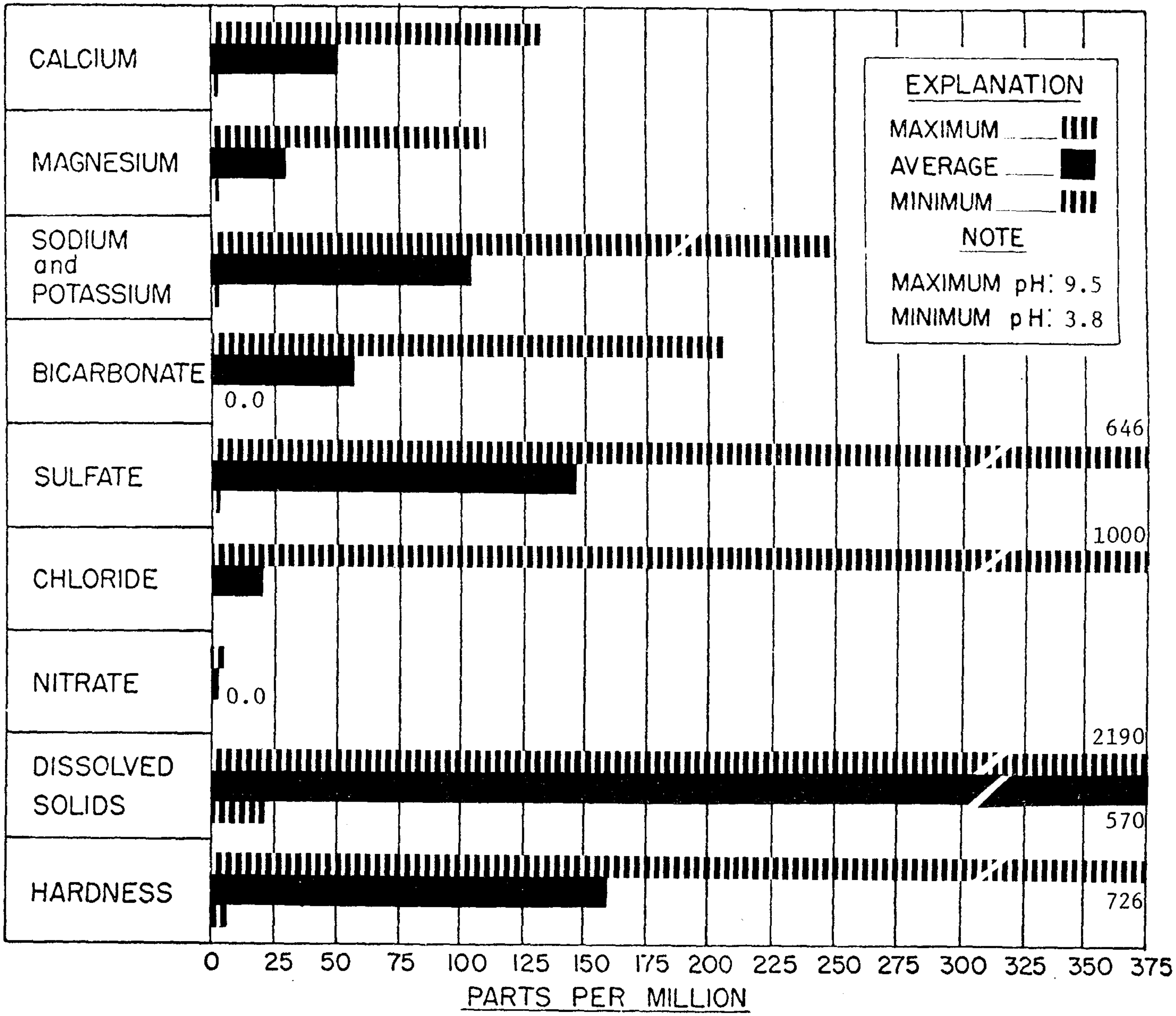
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE H-2

North Fork Kentucky River

Hazard

1-73 to 6-74



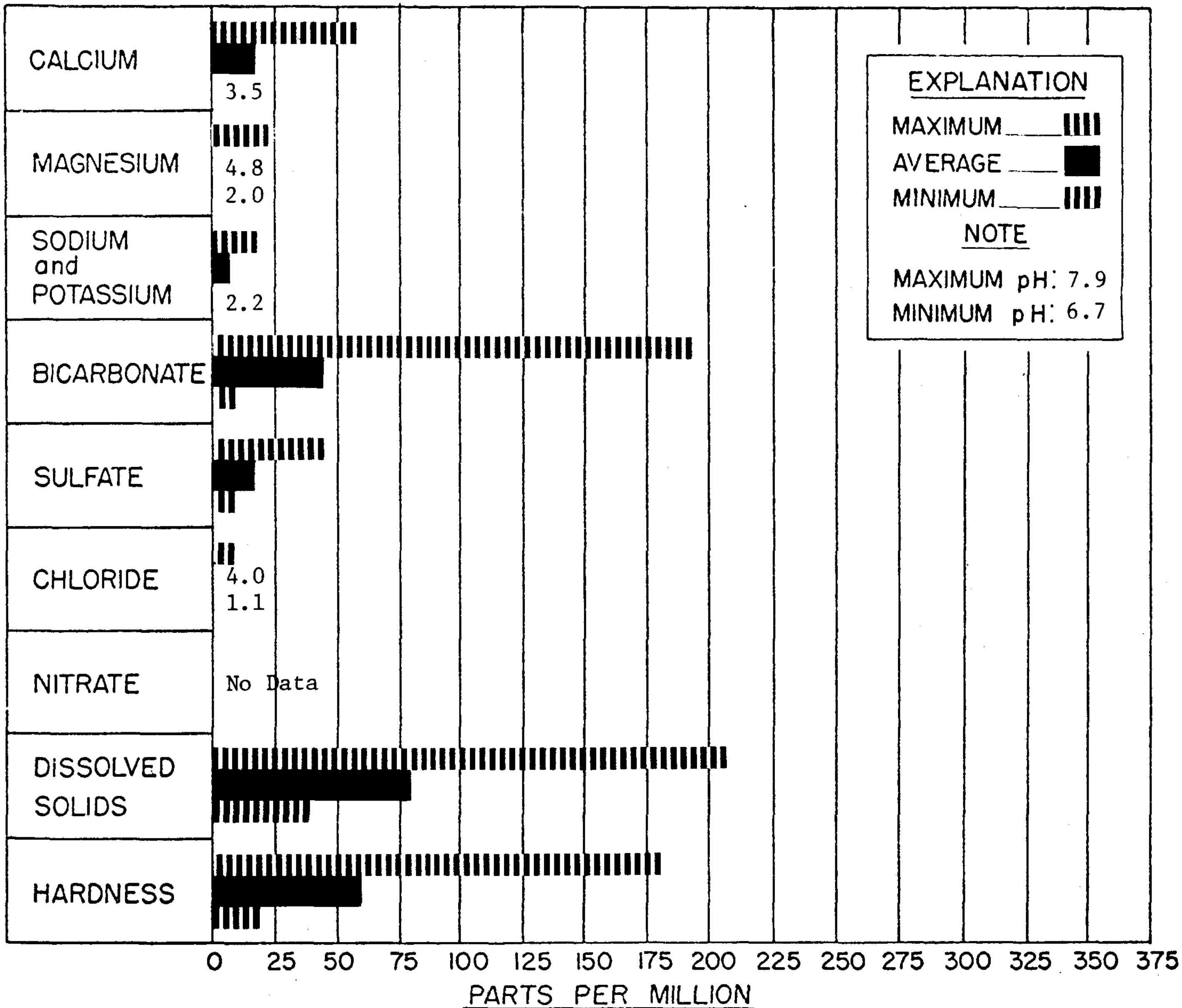
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-3

North Fork Kentu River

Hazard

10-62 to 6-74



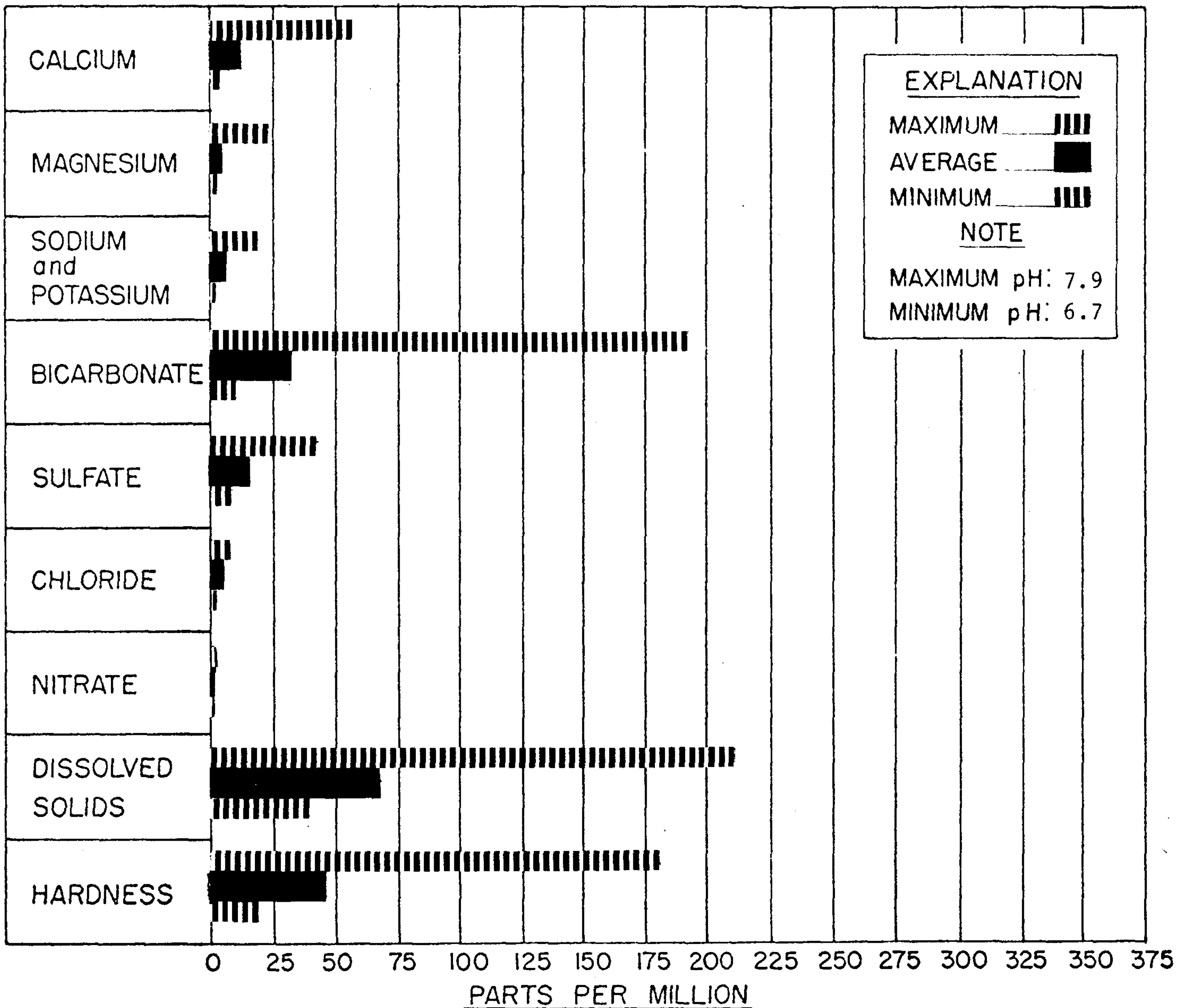
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-4

Red River

Pine Ridge

1-73 to 11-74



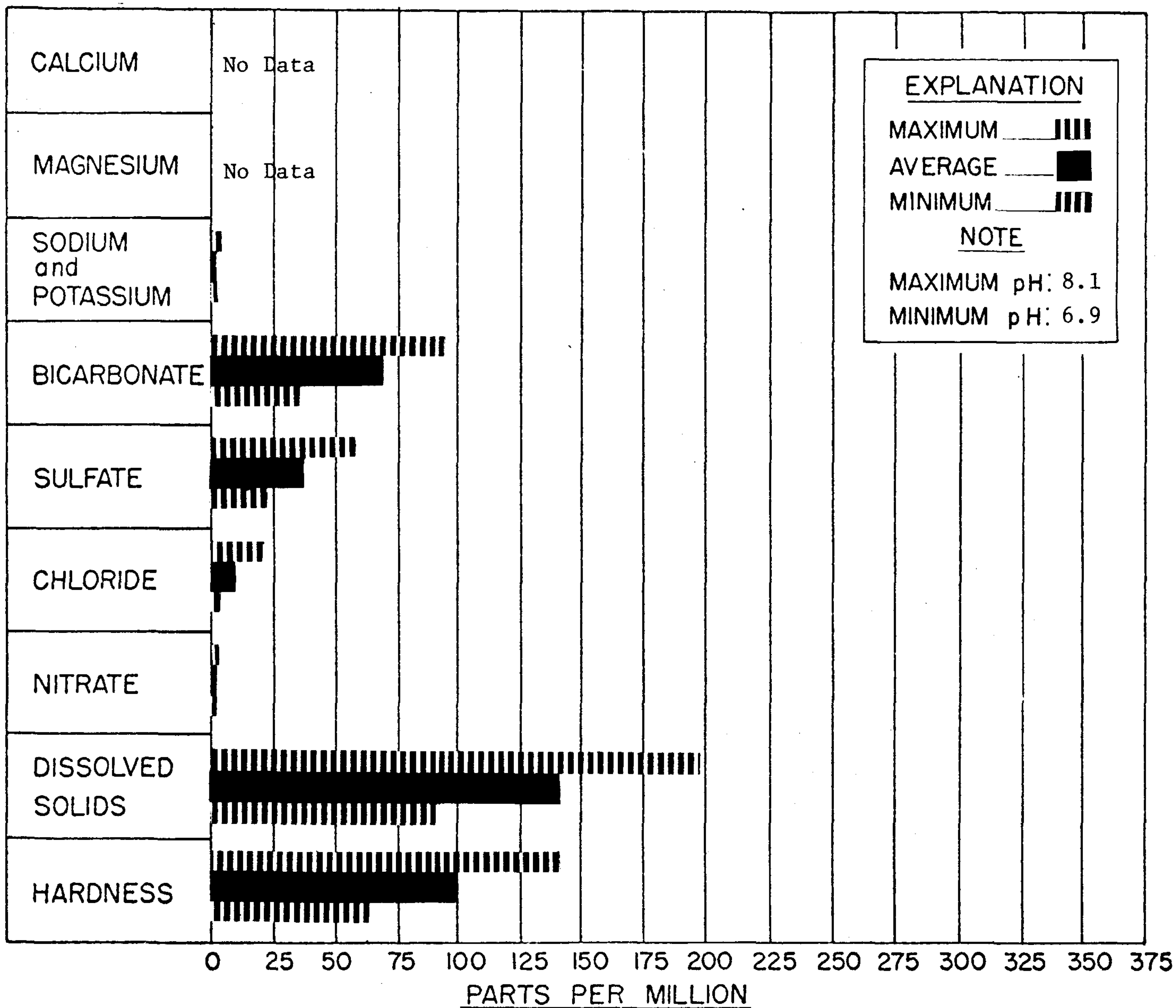
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-5

Red River

Pine Ridge

4-69 to 11-74



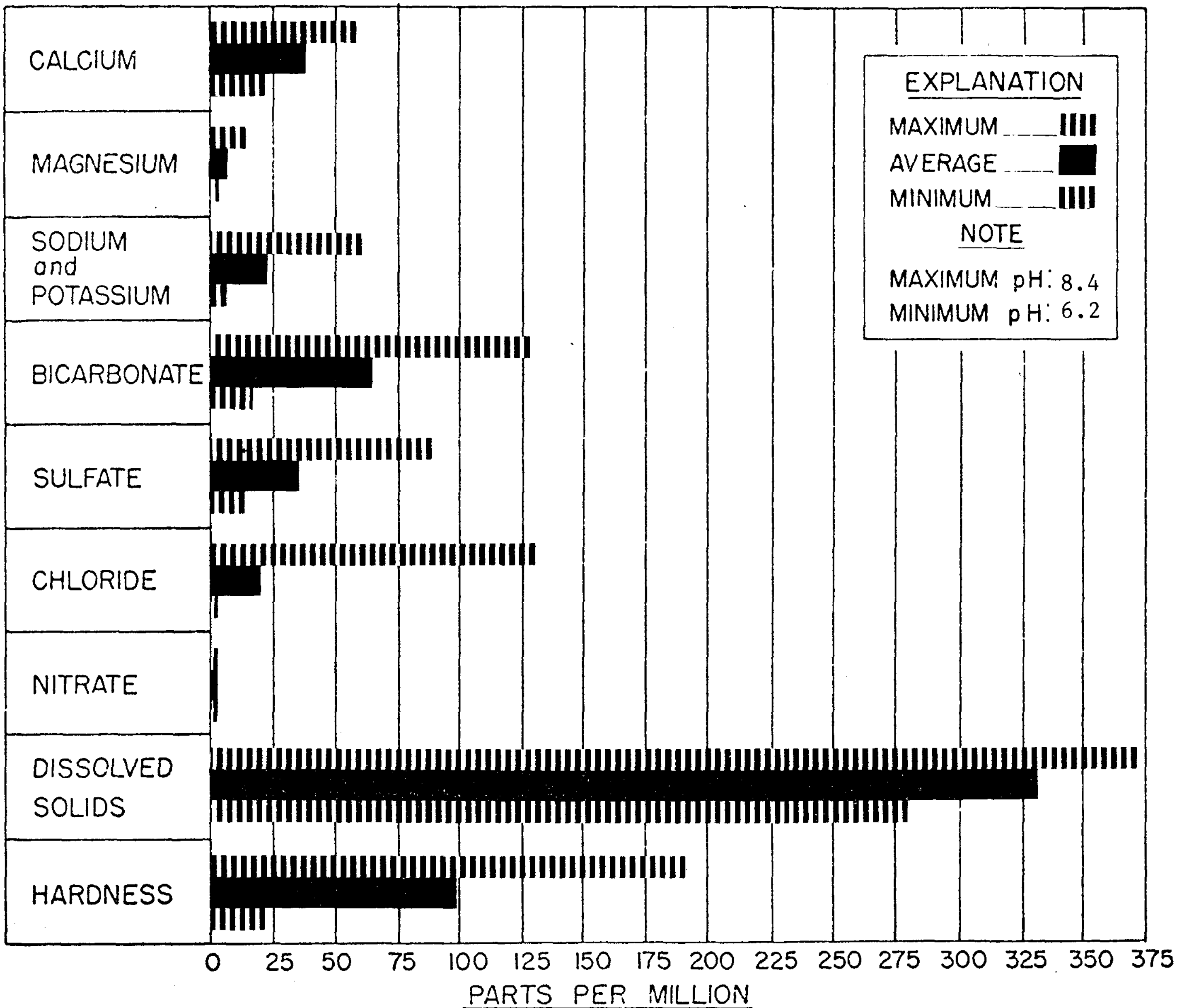
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-6

Kentucky River

Lock 4 at Frankfort

1-73 to 11-74



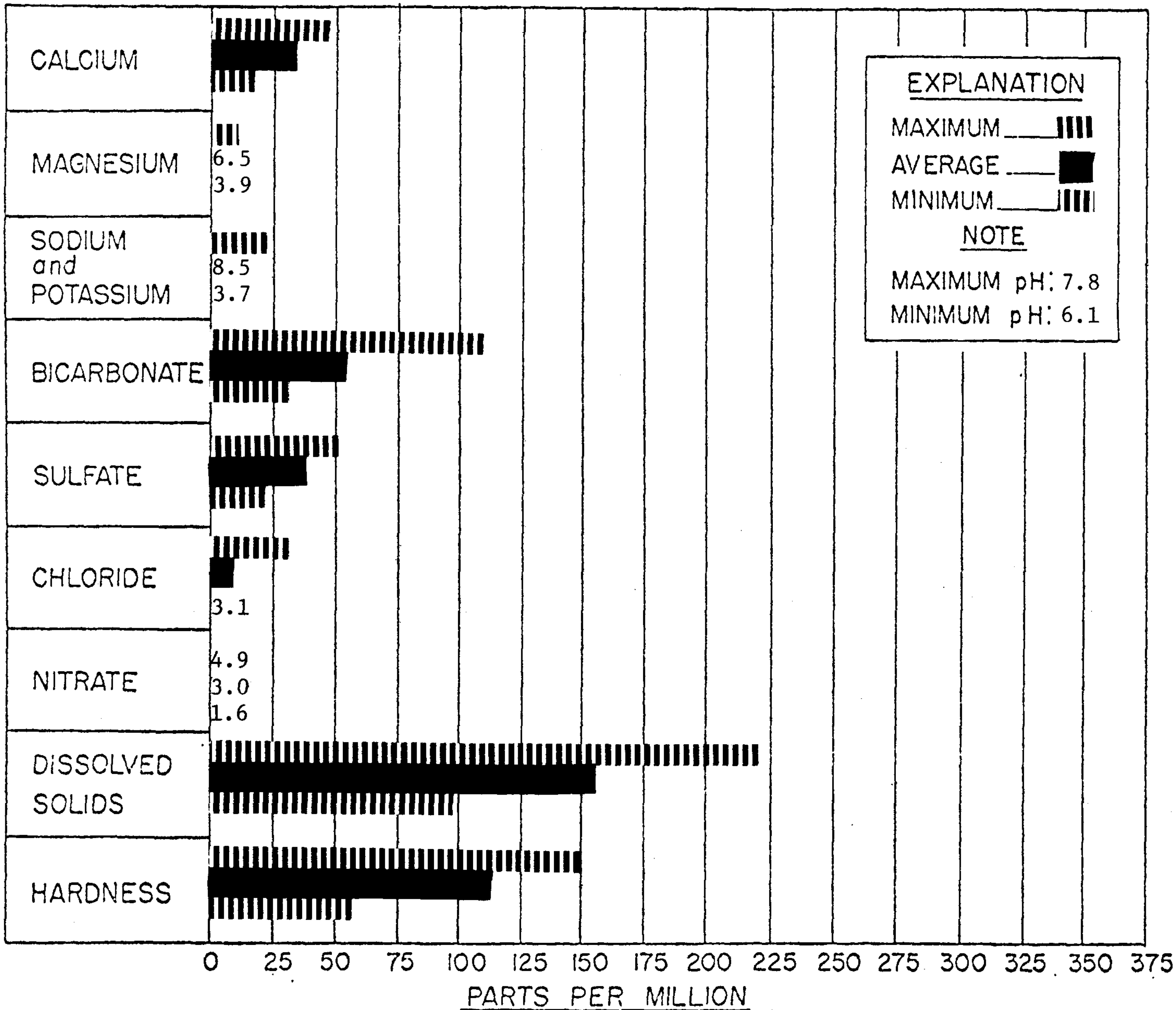
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-7

Kentucky River

Lock 4 at Frankfort

10-59 to 9-73



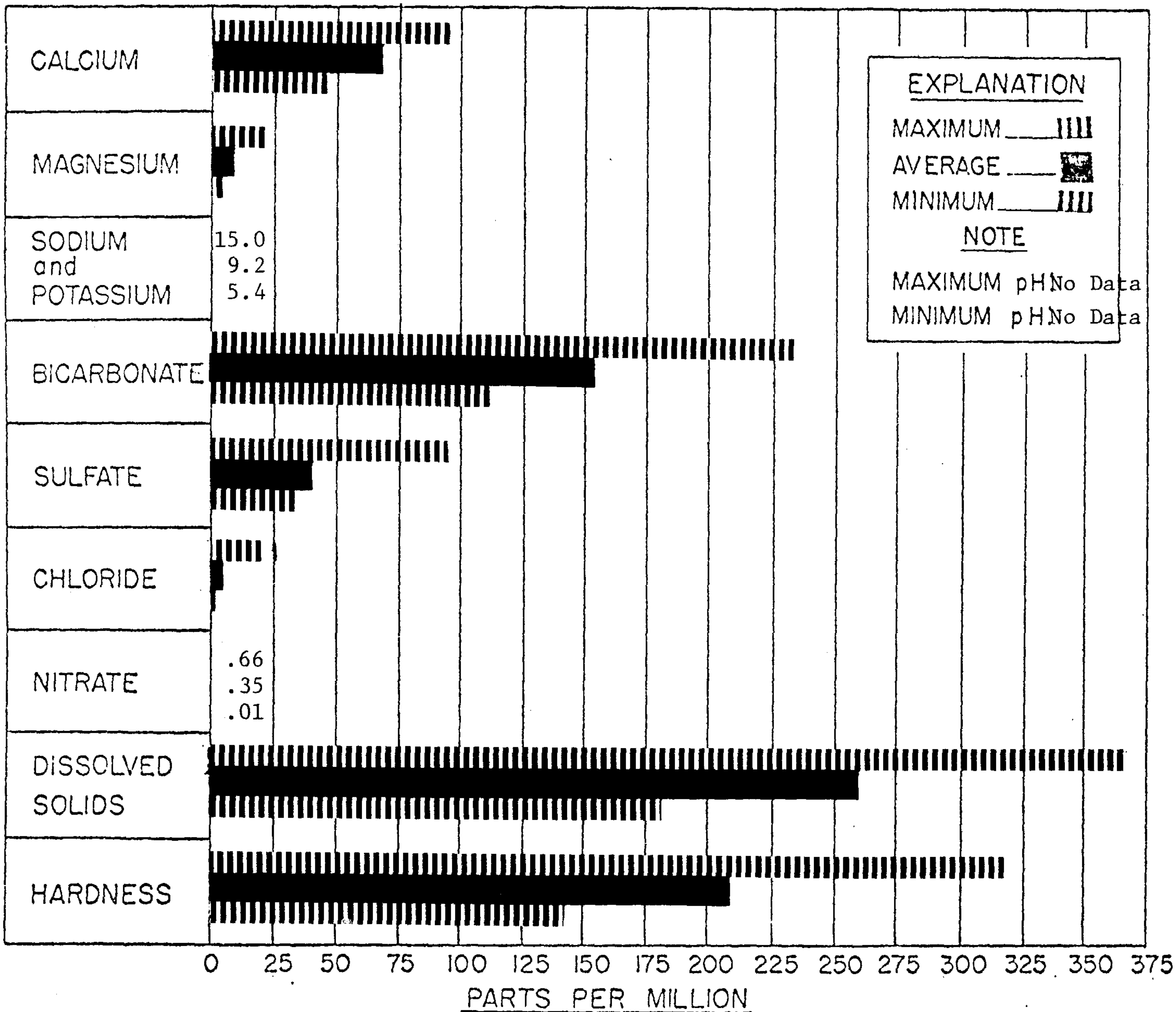
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE H-9

Kentucky River

Lock 2

2-73 to 1-76



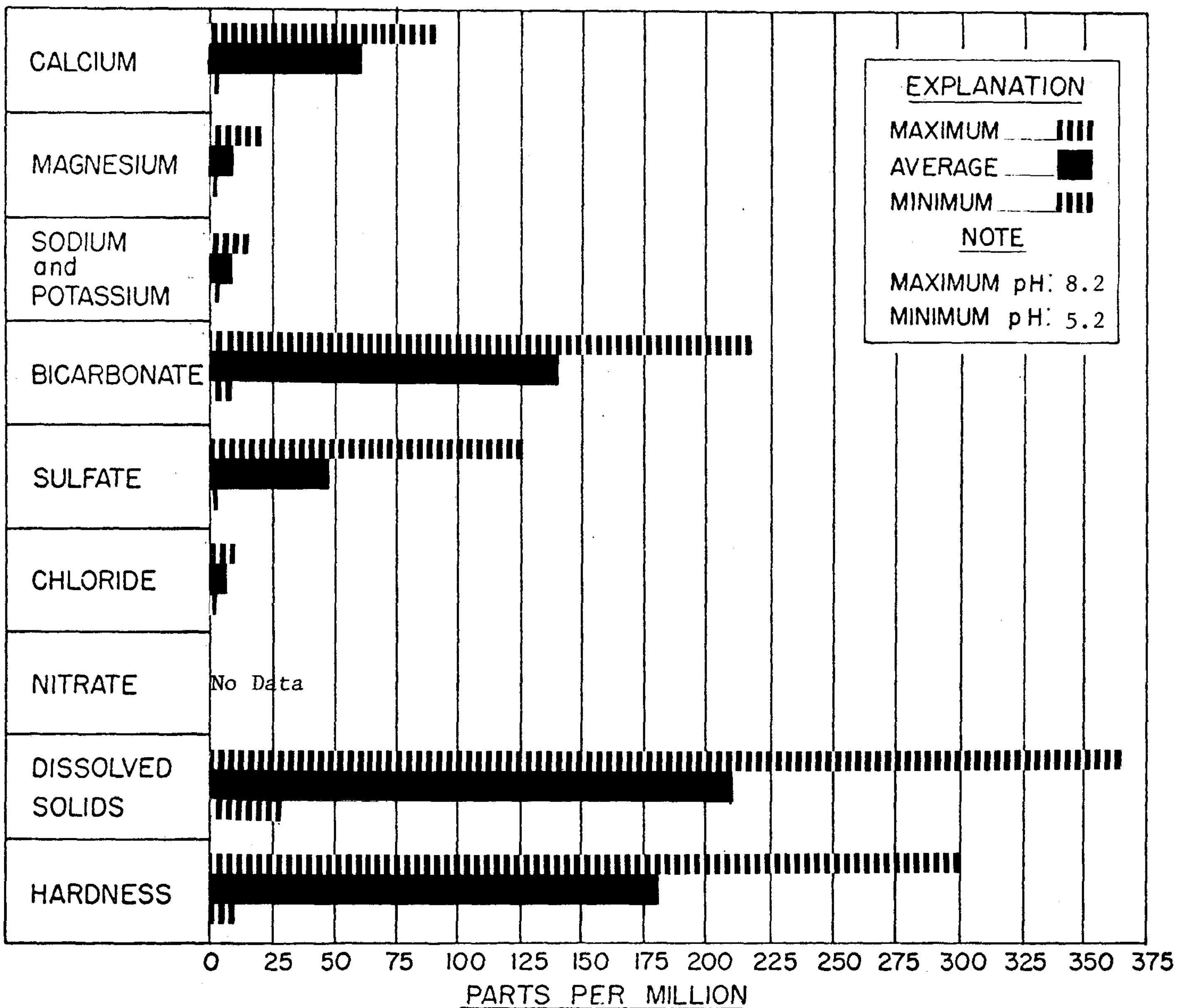
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE H-10

Eagle Creek

Glencoe

1-75 to 11-75



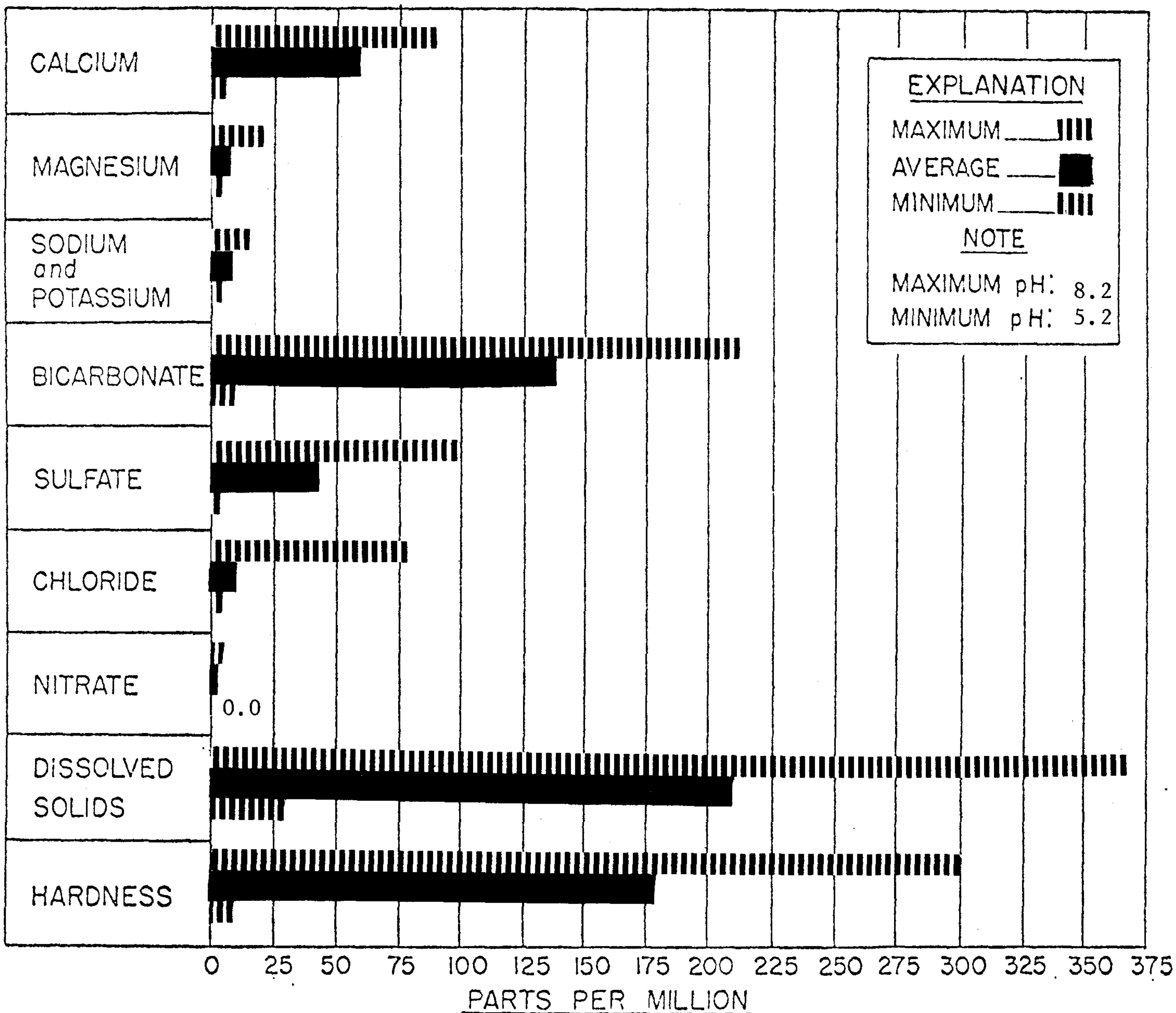
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE H-11

Eagle Creek

Glencoe

2-73 to 11-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE H-12

Eagle Creek

Glencoe

1-62 to 11-74

of less than 60 mg/l). The data studied indicates that the water in the Red River sub-basin is of the highest quality throughout the entire Kentucky River Basin.

The water quality of the main stem of the Kentucky River is demonstrated in Figures H-6 and H-7. This data was collected at Lock 4 near Frankfort and the river at this point is relatively insensitive due to its large drainage basin representation. This means that large influences are required to change the values measured in water quality. This data shows influences from upstream activities by an increase in dissolved solids and an increase in the hardness of the water. The hardness in the main stem is characterized as moderately hard (calcium bicarbonate hardness of 60 - 120 mg/l).

The North Fork of the Kentucky River at Hazard is just downstream of an intensive coal mining area and demonstrates the effects of such on water quality as can be seen in Figures H-2 and H-3 The North Fork is a relatively sensitive station showing a more rapid change in water quality. The water quality has been degraded by an increase in dissolved solids, hardness, sulfate, magnesium, calcium, sodium and potassium. The chloride levels are high as well as the sodium and potassium levels. This can be attributed to materials related to the coal mining industry. The acidity has increased as demonstrated by a decrease in pH. In general the water quality at this station is regarded as poor.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

The trace elements measured in the Kentucky River Basin were less than the Kentucky/FederalStandards for Drinking Water with the following exceptions. The station on the North Fork at Hazard yielded data that exceeded Kentucky/Federal Water Quality Standards in the parameters of iron, manganese, and fluoride. These parameters can be directly or indirectly related to coal mining activities. A point of interest is that 128 million tons of coal were produced in Kentucky in 1973 and it is estimated that by 1985 this production level will reach 400 million tons in Kentucky or over three times that produced in 1973.

D. Waste Load Effects on Water Quality

Within the confines of this report, water quality is considered as affected when the dissolved oxygen concentration drops below 5 mg/l. Approximately 868 miles of stream length were studied under a model used to determine waste load allocations, developed in the Kentucky Continuing Planning Process for River Basin Management Planning. According to this data, approximately 150 miles of that stream length would have a dissolved oxygen concentration of less than 5 mg/l when the flow is equal to or less than the 10 year 7 day low flow. This is highly possible as the flow of many of the tributaries does drop to or below, the 10 year 7 day low flow. It is not predicted that the dissolved oxygen concentration in any segment of the main stem of the river will drop below 5 mg/l.

Of the 150 miles of stream length affected, approximately 124 miles or 83 per cent will be due to municipalities, and 26 miles due to other dischargers such as subdivisions, trailer parks, schools, etc. The waste loads causing this effect totaled approximately 32 million gallons per day (mgd) of discharges with 30 million of it contributed by municipalities and the remaining two million by other discharges.

E. Non-Point Source Effects

Non-point source effects can be summarized in the three categories of agriculture, mining and surface runoff. It is estimated that approximately 1,070 square miles of disturbed forest land, cropland, and field gullies and some 1,700 miles of streambank and roadbank erode excessively and contribute to sediment in the streams. It is further estimated that over 54 square miles of surface mined land is exposed and has an excessive erosion rate.

Surface runoff from urban areas is also a problem in cases where sizable cities are located on low flow streams. There are three such cases in the Kentucky River Basin at the cities of Lexington, Richmond and Danville. This type of source exerts a load on the receiving stream with respect to Biochemical Oxygen Demand (BOD) and suspended solids.

F. Water Uses

The most important use of water is for public water supply. Over 51 million gallons per day is withdrawn for use in this basin. Of this amount, approximately 24 million gallons per day or 48 per cent is used for public supply. The remaining 27 million gallons per day is used for industry. It should be noted that 27 percent, or fourteen million gallons per day, of the total withdrawal is withdrawn from groundwater.

Another major use of water in this basin is for recreational purposes. There are numerous boat docks, camp sites, beaches and other recreational facilities located in the Kentucky River Basin. Furthermore, according to the Kentucky Department of Fish and Wildlife, there are over 2,000 miles of stream in this basin capable of providing a sport fishery with a grand total of 99 species of fishes representing 18 families.

Generally, water in the basin is widely used in the agricultural industry primarily for livestock watering with a small amount used for irrigation. The water in the basin is of sufficient quality for this use except in areas of extensive coal mining, i.e., in the headwaters.

G. Water Quality Changes

In general, the quality of the water in the Kentucky River Basin is not changing according to the data studied. However, the data taken at the station on the North Fork of the Kentucky River at Hazard reveals that the quality of the water is deteriorating. The concentrations of no less than nine of the parameters studied have increased by considerable amounts. With the energy crisis demanding greater and greater amounts of coal, there is the potential for these problems to increase even more. Much care must be taken in this area to prevent the quality of the water from deteriorating as coal production increases and an effort must be made to upgrade the existing quality of the water.

III. Summary

As stated earlier in this report, the quality of the water in the Kentucky River Basin is good at the station on the main stem of the river at Lock 4 near Frankfort, on the Red River at Pine Ridge and on Eagle Creek at Glencoe. However, the station on the North Fork of the Kentucky River at Hazard reflects the effects of coal mining on water quality.

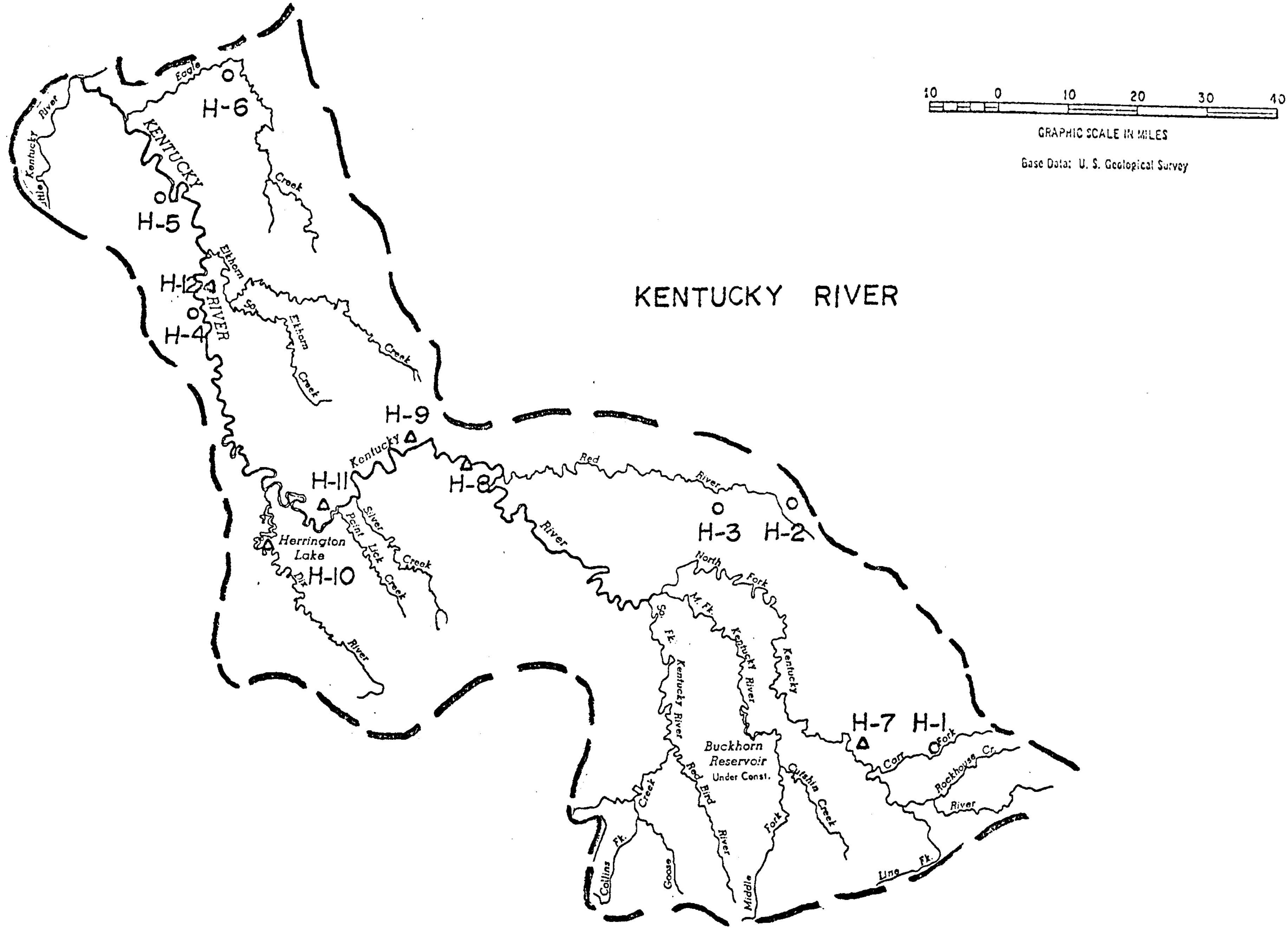
The two main problems in the basin with regards to water quality are siltation and municipal organic wasteloads.

The problem of municipal organic wasteloads is twofold: Inadequate treatment facilities and improper operation of some existing treatment facilities. More emphasis should be placed on the training of wastewater treatment plant operators and recruiting of better qualified personnel to insure proper operation and maintenance of treatment facilities. According to the data, 38 per cent of the existing treatment facilities in this basin need improvements as they are affecting the quality of the water. It should also be noted that 19 per cent of the incorporated cities in the basin presently have no sewers.

The siltation and organic load problems related to urban runoff from sizable cities located on low-flow streams can be improved by the installation or upgrading of storm sewer systems.

The siltation problem related to coal production is localized in the headwaters. The coal producing counties that contribute to this basin are Bell, Clay, Estill, Harlan, Knott, Knox, Leslie, Letcher and Perry. The logging of forest land in preparation for strip mining can result in high runoff rates and serious erosion while the actual strip mining leads to sedimentation from upheval of surface soil. With today's emphasis on increased coal production, this problem will have to be controlled to prevent further degradation of the water quality. As shown earlier in this report, the quality of the water is already below acceptable standards in this area and measures for improvement need to be emphasized and implemented.

The water quality problems related to coal production cannot be over emphasized. The State of Kentucky is the largest coal producing state in the nation and its production level is predicted to triple within the next few years. This amount of coal mining activity could have a disasterous, practically irreversible effect on the quality of the waters of Kentucky.


KENTUCKY RIVER
10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey
H-1
H-2
H-3
H-4
H-5
H-6
H-7
H-8
H-9
H-10
H-11
H-12
KENTUCKY RIVER
Eagle Creek
Elkhorn Creek
So. Elkhorn Creek
Kentucky River
Red River
Silver Creek
Paint Lick Creek
Dix River
Herrington Lake
North Fork Kentucky
M. Fk. Kentucky River
So. Fk. Kentucky River
Buckhorn Reservoir
Under Const.
Carr Fork
Rockhouse Cr.
Cutshin Creek
Red Bird River
Middle Fork
Goose Creek
Collins Fk.
Line Fk.

STATION KEY

H-1	CARR FORK NEAR SASSAFRAS
H-2	RED RIVER NEAR HAZEL GREEN
H-3	RED RIVER NEAR PINE RIDGE
H-4	KENTUCKY RIVER AT LOCK 4
H-5	KENTUCKY RIVER AT LOCK 2
H-6	EAGLE CREEK AT GLENCOE
H-7	NORTH FORK KENTUCKY RIVER AT HAZARD
H-8	KENTUCKY RIVER AT RICHMOND
H-9	KENTUCKY RIVER AT LEXINGTON WPI
H-10	DIX RIVER AT DANVILLE WPI
H-11	KENTUCKY RIVER AT LOCK 8
H-12	KENTUCKY RIVER AT FRANKFORT WPI

TABLE H-1

SUB-BASINS OF 200 SQUARE MILES OR GREATER IN

THE KENTUCKY RIVER BASIN

Sub-basins	Square Miles
North Fork of Kentucky	1,883.0
South Fork of Kentucky	748.0
Middle Fork of Kentucky	559.0
Red River	487.00
Dix River	442.0
Elkhorn Creek (at lower Dam Site) Mile 2.5	492.0
Eagle Creek	519.0
Station Cam Creek	217.0

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning Effort.

TABLE H-2

COUNTY AREA IN THE KENTUCKY RIVER BASIN

County	Total Area (sq. miles)	Area in Basin (sq. miles)	County	Total Area (sq. miles)	Area in Basin (sq. miles)
Anderson	206	70	Lee	210	210
Bell	370	15	Leslie	409	409
Boyle	183	80	Letcher	339	290
Breathitt	494	494	Lincoln	340	187
Carroll	130	86	Madison	446	446
Clark	259	130	Menifee	210	65
Clay	474	430	Mercer	256	102
Estill	260	260	Montgomery	204	35
Fayette	280	280	Owen	351	351
Franklin	211	211	Owsley	197	197
Garrard	236	236	Perry	341	341
Grant	249	249	Powell	173	173
Harlan	469	70	Rockcastle	311	60
Henry	289	260	Scott	284	284
Jackson	337	135	Shelby	383	70
Jessamine	177	177	Trimble	146	60
Knott	356	255	Wolfe	227	227
Knox	373	38	Woodford	193	193
			Total		7,033

SOURCE: Rand McNally Standard Reference Map and Guide of Kentucky, 1972.

TABLE H-3

SLOPES AND ELEVATIONS OF PRINCIPAL TRIBUTARIES

IN THE KENTUCKY RIVER BASIN

STREAM	LENGTH (Miles)	Max. El. (m.s.l.)	Min. El. (m.s.l.)	AVERAGE SLOPE (ft./miles)
N. Fork of Kentucky River	148.1	1,109	634	3.21
M. Fork of Kentucky River	43.3	757	627	3.00
S. Fork of Kentucky River	85.0	1,250	634	7.25
Goose Creek	21.8	830	754	3.49
Troublesome Creek	42.4	1,004	720	6.69
Red River	59.5	713	566	2.47
Otter Creek	13.1	880	566	23.97
Boone Creek	7.2	780	549	32.08
Silver Creek	39.2	936	531	10.33
Paint Lick Creek	32.0	920	531	12.16
Hickman Creek	31.5	910	514	12.57
Jessamine Creek	13.1	860	519	26.03
Clarks Run Creek	10.4	920	750	16.35
Dix River H.W. to mp 34.6	23.2	822	750	3.27
	0.0 slope from mp 34.60 to mouth including reservoir			
Glenns Creek	12.5	830	469	28.88
Elkhorn Creek	90.6	950	454	5.48
Drennon Creek	16.6	800	428	22.41
Stephens Creek	20.9	920	598	15.41
Clarks Creek	15.4	791	586	13.31
Eagle Creek	81.4	737	428	3.80
Little Eagle Creek	12.6	914	737	14.05

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e River Basin Planning Effort.

TABLE H-5

LAKES IN THE KENTUCKY RIVER BASIN

Location	County	Surface Area (Acres)	Capacity Acre-Feet
Fishpond Lake	Letcher County	31	1,037
Taylor Fork Lake	Madison County	169	3,572
Corinth Lake	Grant County	96	1,612
Bullock Pen	Grant County	134	2,464
Elmer Davis Lake	Owen County	149	3,151
Pan Bowl Lake	Jackson County	98	1,298
Lexington Reservoirs	Fayette County	408	3,850
Mill Creek Lake	Wolfe County	41	1,049
Elk Lake	Owen County	207	2,654
Herrington Lake	Mercer County	2,940	230,500
Kentucky Utility Fly Ash Disposal	Carroll County	89	2,491
Lake Vega	Madison County	132	1,557
Boltz Lake	Grant County	92	2,168
Total	--------------------	4,586	257,403
Federal			
Buckhorn Lake	Leslie & Perry County	1,230	21,800
Carr Fork Lake	Knott County	710	6,480
Total	--------------------	1,940	28,280
Grand Total	--------------------	6,526	285,683

SOURCE: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Resources.

Table H - 6

City Population and Facility Grant Status in the Kentucky River Basin in Kentucky

County	City	Population	Project Type	Comments
Anderson				
Bell				
Boyle	Danville- Junction City	12,400 1,046	I	Underway
Breathitt	Jackson	1,887	I	Underway
Carroll	Carrol	3,884	I	Pending
Clark				
Clay	Manchester	1,664	I	Underway
Estill	Irving- Ravenna	2,918 734	I	Underway
Fayette	Lexington-Main	73,500	I	Underway
	Lexington-West Hickman	43,500	I	Underway
Franklin	Frankfort	22,700	I	Underway
Garrard	Lancaster	3,230	I	Underway
Grant	Williamstown	2,063	I	Underway
	Dry Ridge	1,100	III	Underway
Harlan				

Table H - 6
Continued

County	City	Population	Project Type	Comments
Henry	New Castle	755	I	Underway
Jackson				
Jessamine	Nicholasville	5,829	I	Underway
	Wilmore	3,466	None	Sewered
Knott	Hindman	808	I	Pending
Knox				
Lee	Beattyville	923	I	Underway
Leslie	Hyden	482	None	Sewered
Letcher	Whitesburg	1,137	I	Pending
	Neon-Fleming	1,178	II	Pending
Lincoln	Stanford	2,474	I	Underway
	Crab Orchard	861	I	No Sewers
	Hustonville	413	I	No Sewers
Madison	Berea #1	4,600	I	Underway
	Berea #2	2,300	I	Underway
	Richmond #1	10,100	I	Underway
	Richmond #2	7,700	I	Underway
Menifee				
Mercer	Burgin	1,002	I	Underway
Montgomery				

Table H - 6
Continued

County	City	Population	Project Type	Comments
Owen	Owenton	1,280	I	Pending
Owsley	Booneville	126	None	Sewered
Perry	Hazard	5,459	I	Pending
	Vicco	377	I	Underway
Powell	Stanton-Clay City	2,037	I	Underway
Rockcastle	Brodhead	769	None	Sewered
Scott	Georgetown	8,629	I	Underway
	Stamping Ground	411	III	No Sewers
	Sadieville	272	None	No Sewers
Shelby				
Trimble				
Wolfe	Campton	419	I	Underway
Woodford	Versailles	5,679	I	Underway
	Midway	1,278	I	Pending

Source: Kentucky Department for Natural Resources and Environmental Protection, Division of Water Quality

TABLE H-7

Organic Loads Affecting Streams in the Kentucky River Basin

Length of streams to which treated organic loads are discharged		868
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		145
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	119
	Industrial Discharges	---
	Other Discharges	26

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicated the stream miles in which the dissolved oxygen is predicted to be less than 5 mg.l when the stream flow is less than the once in ten year, seven day, low flow.

Table H-8

LOCKS AND DAMS ON THE KENTUCKY RIVER

Lock No.	Miles Above Mouth	Length of Pool Above Dam (miles)
1	4.0	27.0
2	31.0	11.0
3	42.0	23.0
4	65.0	17.2
5	82.2	14.0
6	96.2	20.8
7	117.0	22.9
8	139.9	17.6
9	157.5	18.9
10	176.4	24.6
11	201.0	19.9
12	220.9	19.0
13	239.9	9.1
14	249.0	-

Navigation Charts
U. S. Army Corps of Engineers
Louisville District

Table H-9

Water Quality Data for the Kentucky River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00400	pH Specific Units Kentucky Standard 6-LT pH LT 9						
Carr Fork near Saasafras U.S.G.S. 03277450	70/07/07	74/07/16	7.18	8.0	6.4	33	.360
North Fork Kentucky	75/01/16	75/01/16	7.4			1	
River at Hazard	70/01/31	74/06/11	7.4	8.2	6.2	91	.413
U.S.G.S. 0327750	65/01/07	75/01/16	7.3	8.2	3.8	210	.530
	62/01/08	74/06/--	7.2	9.5	3.8	276	0.7
Red River near Hazel Green U.S.G.S. 03282500	70/10/02	72/09/12	7.1	7.3	6.8	3	.289
Red River near	71/01/13	74/07/08	7.1	7.8	6.7	33	.237
Pine Ridge	69/08/08	70/11/04	7.3	7.7	6.7	13	.326
U.S.G.S. 03283100	69/03/20	69/03/05	7.5	7.5	7.5	2	.00
Kentucky River Lock 4	70/01/02	73/09/26	7.6	8.1	6.8	92	.308
U.S.G.S. 03287500	65/01/13	73/09/26	7.5	8.4	6.7	208	.334
	59/10/25	73/09/26	7.5	8.4	5.2	206	.370
Kentucky River Lock 2	75/01/07	75/01/07	7.0	7.8	6.1	13	.459
U.S.G.S. 03290500	73/02/07	74/11/05	7.4	7.7	6.5	17	.294
Eagle Creek at Glencoe	75/07/14	75/07/14	7.7			1	
U.S.G.S. 03291500	70/08/06	74/10/07	7.6	8.1	7.0	39	.267
	62/01/25	74/10/07	7.6	8.1	7.0	41	.263
STORET #00095	Conductivity Micromhos, Kentucky Standard 800 micromhos						
Carr Fork near	75/01/28	75/11/12	317.3	554.0	171.0	8	156.2
Sassafras	70/07/07	74/12/17	295.0	507.0	84.0	41	94.2
North Fork Kentucky	75/01/16	75/01/16	271.0			1	
River at Hazard	70/01/31	74/06/11	392.4	946.0	100.0	93	197.5
	62/10/08	74/06/11	7.2	8.2	3.8	264	.599
Red River near Hazel Green	70/10/02	72/09/12	145.0	157.0	126.0	277.1	16.6
Red River near	75/01/21	75/12/03	90.1	134.0	58.0	8	28.0
Pine Ridge	71/01/13	74/07/08	92.7	148.0	58.0	37	26.3
	69/08/08	70/11/04	121.5	160.0	76.0	13	27.9
	68/11/21	69/06/05	99.0	110.0	82.0	3	14.9

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Kentucky River Lock 4	75/03/14	75/03/14	210.0			1	
	70/01/02	74/08/26	258.1	646.0	115.0	96	98.3
	65/01/13	74/08/26	265.4	675.0	115.0	222	104.4
	59/10/03	74/08/26	253.0	675.0	76.0	388	94.9
Kentucky River Lock 2	75/01/07	76/01/07	232.0	275.0	185.0	11	32.1
	73/02/07	74/12/09	248.6	336.0	123.0	23	40.0
Eagle Creek at Glencoe	75/01/30	75/11/07	436.0	160.0	10.0	7	101.5
	70/08/06	74/12/09	365.8	617.0	204.0	48	85.6
	70/08/06	74/12/09	365.8	617.0	204.0	48	85.6
	62/01/25	74/12/09	361.2	617.0	204.0	50	86.8
STORET #70300	Dissolved Solids Milligrams/liter KY. Std. 500 mg/l						
Carr Fork near Sassafras	75/01/28	75/12/17	193.3	321.0	106.0	9	86.6
	70/07/07	74/12/17	189.6	326.0	48.0	41	60.6
North Fork Kentucky River at Hazard	70/01/31	74/06/11	259.3	676.0	58.0	91	141.1
	65/01/07	74/06/11	267.9	810.0	58.0	219	147.5
	62/10/08	74/06/11	290.8	1800.0	58.0	294	188.7
Red River near Hazel Green	70/10/02	72/09/12	90.0	100.0	74.0	3	14.0
Red River near Pine Ridge	75/01/21	75/10/21	58.9	96.0	30.0	8	21.5
	74/10/01	74/12/16	69.0	74.0	64.0	2	7.07
	70/11/04	69/08/08	73.4	94.0	41.0	13	15.6
	69/03/20	69/06/05	62.5	73.0	52.0	2	14.8
Kentucky River Lock 4	70/01/02	73/09/26	158.5	400.0	54.0	92	60.5
	65/01/13	73/09/26	162.6	400.0	54.0	218	62.8
	59/10/03	73/09/26	150.2	400.0	8.2	414	55.5
Kentucky River Lock 2	75/01/07	74/12/04	148.8	215.0	118.0	12	26.3
	73/02/07	74/12/09	160.4	220.0	96.0	24	26.0
Eagle Creek at Glencoe	75/01/30	75/12/18	260.0	368.0	184.0	7	63.6
	70/08/06	74/12/09	231.6	385.0	136.0	48	54.6
	70/08/06	74/12/09	231.6	385.0	136.0	48	54.6
	62/01/25	74/12/09	229.0	385.0	136.0	50	55.0
STORET #00410	Alkalinity mg/l No Standard						
Carr Fork near Sassafras	75/01/28	75/12/17	73.3	201.0	21.0	9	63.1
	70/07/07	74/12/17	51.2	141.0	11.0	41	31.8

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
North Fork Kentucky	75/01/16	75/01/16	43.0			1	
Hazard	70/01/31	74/06/11	52.0	125.0	8.0	91	29.4
	62/12/20	74/06/11	49.2	125.0	.00	170	38.6
	65/01/07	74/06/--	55.0	205.0	0.0	177	42.0
Red River near Hazel Green	70/10/02	72/09/12	43.7				
Red River near	75/01/21	75/10/21	25.4	41.0	10.0	8	11.9
Pine Ridge	74/10/01	74/12/16	26.5	33.0	20.0	2	9.2
	71/01/13	74/07/08	25.5	51.0	9.0	37	13.1
	69/08/08	70/11/04	33.2	54.0	13.0	13	12.8
	69/03/20	69/06/05	26.0	33.0	19.0	2	9.9
Kentucky River Lock 4	70/01/02	73/09/26	65.4	156.0	28.0	92	20.5
	65/01/13	73/09/26	65.4	156.0	28.0	166	18.8
	59/10/25	73/09/26	65.0	156.0	16.0	229	20.0
Kentucky River Lock 2	75/01/07	75/12/04	76.3	103.0	59.0	12	12.9
	73/02/07	74/12/09	79.2	110.0	28.0	24	17.4
Eagle Creek at	75/01/30	75/12/18	153.1	232.0	112.0	9	38.5
Glencoe	70/08/06	74/12/09	142.5	217.0	78.0	48	32.5
STORET #00900	Hardness mg/l, 0-60 Soft, 61-120 moderately hard, 121-180 hard, over 180 very hard						
Carr Fork near	75/01/28	75/12/17	122.6	200.0	74.0	9	49.5
Sassafras	70/07/07	74/12/17	122.2	233.0	36.0	41	41.1
North Fork Kentucky	70/01/31	73/09/15	148.5	370.0	12.0	90	78.9
River, Hazard	65/01/07	73/09/15	148.2	422.0	12.0	208	79.1
	62/10/08	73/09/15	157.9	1090.0	12.0	257	107.2
Red River near Hazel Green	70/10/02	72/09/12	59.0	71.0	48.0	3	11.5
Red River near	75/01/21	75/10/21	37.5	55.0	25.0	8	10.9
Pine Ridge	74/10/01	74/12/16	42.5	52.0	33.0	2	13.4
	71/01/13	74/07/08	36.7	59.0	18.0	36	12.0
	69/08/08	70/11/04	46.2	62.0	25.0	13	11.6
	69/03/20	69/06/05	38.5	47.0	30.0	2	12.0
Kentucky River Lock 4	70/01/02	73/09/26	104.5	190.0	49.0	92	31.7
	65/01/13	73/09/26	104.7	192.0	48.0	208	30.8
	59/10/03	73/09/26	99.2	192.0	21.0	381	28.9

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Kentucky River Lock 2	75/01/07	75/12/04	110.4	130.0	90.0	12	14.8
	73/02/07	74/12/09	113.3	150.0	56.0	24	18.6
Eagle Creek at Glencoe	75/01/30	75/12/18	208.9	320.0	140.0	9	54.4
	70/08/06	74/12/09	185.0	300.0	94.0	48	47.1
	62/01/25	74/12/09	182.4	300.0	94.0	50	47.8
STORET #00080	Color Platinum - Cobalt Units, Prop. EPA Std. 75 Units						
Carr Fork near Sassafras	75/01/28	75/12/17	210.4	1200.0	1.0	9	405.3
	70/07/07	74/12/17	39.6	500.0	4.0	40	92.4
North Fork Kentucky River at Hazard	70/11/03	72/10/15	8.3	15.0	.00	3	7.6
	65/01/07	72/10/15	8.2	50.0	.00	68	9.0
	62/10/08	72/10/15	7.9	50.0	.00	117	8.4
Red River near Pine Ridge	75/01/21	75/10/21	13.1	40.0	5.0	8	12.0
	74/10/01	74/12/16	10.0	10.0	10.0	2	.00
	71/01/13	74/07/08	16.4	70.0	5.0	34	15.4
	69/08/08	70/11/04	12.8	25.0	4.0	13	7.8
	69/03/20	69/06/05	7.5	10.0	5.0	2	3.5
Kentucky River Lock 4	70/10/07	72/10/21	6.6	10.0	.00	3	5.8
	65/01/13	72/10/21	8.0	50.0	.00	65	8.2
	59/10/25	72/10/21	8.9	50.0	.00	138	7.8
Eagle Creek at Glencoe	75/01/30	75/12/18	47.9	160.0	10.0	9	48.6
	70/08/06	74/12/09	49.2	300.0	5.0	45	52.8
	62/01/25	74/12/09	48.5	300.0	5.0	47	51.7
STORET #00930	Sodium mg/l, No Standard						
Carr Fork near Sassafras	75/01/28	75/12/17	14.2	52.0	2.9	9	16.5
	70/07/07	74/12/17	10.1	33.0	1.6	41	6.2
North Fork Kentucky River at Hazard	70/11/03	72/10/15	38.0	56.0	26.0	3	15.9
	65/07/25	72/10/15	38.2	60.0	17.0	9	18.9
Red River near Pine Ridge	74/10/01	74/12/16	2.6	3.0	2.1	2	.636
	71/01/13	74/07/08	2.7	4.8	1.4	36	.889
	69/08/08	70/11/04	3.9	6.2	2.2	13	1.25
	69/03/20	69/06/05	3.1	3.2	2.9	2	.212
Kentucky River Lock 4	70/10/07	72/10/21	42.3	56.0	34.0	3	11.0
	67/07/27	72/10/21	42.2	56.0	33.0	6	10.5
	59/10/25	72/10/21	17	56.0	4.1	17	18.3

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Kentucky River Lock 2	75/01/07	75/12/04	6.5	16.0	3.3	12	3.73
	73/02/07	74/12/09	6.1	14.0	2.3	24	2.54
Eagle Creek at Glencoe	75/01/30	75/12/18	6.2	11.0	3.5	9	2.24
	70/08/06	74/12/09	4.6	9.1	1.7	47	1.72
	62/01/25	74/12/09	4.5	9.1	1.7	49	1.77
STORET #00934	Potassium mg/1, No Standard						
Carr Fork near Sassafras	75/01/28	75/12/17	2.6	4.0	1.60	9	.889
	70/07/07	74/12/17	2.9	5.8	1.4	41	1.03
North Fork Kentucky River at Hazard	70/11/03	72/10/15	5.8	8.0	3.4	3	2.31
	65/07/25	72/10/15	5.3	8.0	3.4	6	1.70
Red River near Pine Ridge	75/01/21	75/10/21	1.9	4.2	1.0	8	1.10
	74/10/01	74/12/16	1.6	2.0	1.1	2	.636
	71/01/13	74/07/08	1.9	3.6	1.0	36	.678
	69/08/08	70/11/04	2.3	3.8	1.4	13	.684
	69/03/20	69/06/05	1.5	1.9	1.0	2	.636
Kentucky River Lock 4	70/10/07	72/10/21	3.9	4.6	3.4	3	.611
	67/07/27	72/10/21	3.4	4.6	2.7	6	.713
	59/10/25	72/10/21	2.6	4.6	1.6	17	.801
Kentucky River Lock 2	75/01/07	75/12/04	2.1	3.3	1.4	58	.583
	73/02/07	74/12/09	2.5	3.7	1.5	24	.75
Eagle Creek near Glencoe	74/01/30	75/12/18	3.0	4.0	1.9	9	.813
	70/08/06	74/12/09	3.4	5.8	1.7	47	1.10
	62/01/25	74/12/09	3.4	5.8	1.7	49	1.10
STORET #00940	Chloride mg/1, Prop. EPA Standard 250 mg/1						
Carr Fork near Sassafras	75/01/28	75/12/17	3.9	10.0	1.2	9	2.89
	70/07/07	74/12/17	4.5	13.0	1.0	41	2.78
North Fork Kentucky near Hazard	75/01/16	75/01/16	7.3			1	
	70/01/31	73/09/15	6.2	36.0	1.5	90	5.09
	62/10/08	73/09/15	7.7	40.0	.00	257	6.31
Red River near Hazel Green	70/10/02	72/09/12	6.3	6.7	5.7	3	.513

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Red River near Pine Ridge	75/01/21	75/01/21	2.8	5.2	1.4	8	1.27
	74/10/01	74/12/16	2.9	2.9	2.9	2	.000
	71/01/13	74/07/08	3.7	7.0	1.1	36	1.52
	69/08/08	70/11/04	5.6	8.0	3.0	13	1.57
	69/03/20	69/06/05	3.5	4.0	3.0	2	.707
Kentucky River Lock 4	70/01/02	73/09/26	16.0	130.0	1.9	92	20.1
	65/01/13	73/09/26	19.7	130.0	1.9	208	23.7
	59/10/25	73/09/26	19.6	130.0	1.9	283	22.9
Kentucky River Lock 2	75/01/07	75/12/04	9.1	29.0	3.5	12	7.04
	73/02/07	74/12/09	9.2	18.0	3.1	24	3.50
Eagle Creek at Glencoe	75/01/30	75/12/18	7.3	18.0	3.0	8	4.44
	70/08/06	74/12/09	8.0	80.0	2.3	48	10.9
	62/01/25	74/12/09	7.7	80.0	1.0	50	10.7
STORET # 00945	Sulfate (mg/1), Prop. EPA Standard 250 mg/1						
Carr Fork near Sassafras	70/07/07	74/12/17	83.9	186.0	23.0	41	26.9
North Fork Kentucky River at Hazard	75/01/16	75/01/16	71.0			1	
	70/01/31	74/06/11	132.2	340.0	13.0	91	74.4
	62/10/08	74/06/11	150.6	997.0	13.0	258	108.1
Red River near Hazel Green	70/10/02	72/09/12	16.7	19.0	13.0	3	3.2
Red River near Pine Ridge	75/01/21	75/10/21	12.5	13.0	11.0	8	.756
	74/10/01	74/12/16	14.0	14.0	14.0	2	.000
	71/01/13	74/07/08	13.8	20.0	9.8	37	2.15
	69/03/20	69.06/05	15.0	15.0	15.0	2	.000
Kentucky River Lock 4	70/01/02	73/09/26	37.8	89.0	18.0	92	13.2
	65/01/13	73/09/26	35.8	89.0	17.0	208	12.0
	59/10/25	73/09/26	34.0	89.0	13.0	283	11.9
Kentucky River Lock 2	75/01/07	75/12/04	32.0	44.0	25.0	12	6.47
	73/02/07	74/12/09	32.0	51.0	21.0	24	7.66
Eagle Creek at Glencoe	75/01/30	75/12/18	53.1	91.0	35.0	8	17.7
	70/08/06	74/12/09	43.5	100.0	19.0	48	15.9
	62/01/25	74/12/09	42.7	100.0	19.0	50	16.2

Table H- 9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Eagle Creek at Glencoe	75/01/30	75/12/18	.27	.60	.10	9	.141
	70/08/06	74/12/09	.29	1.1	.10	48	.188
	62/01/25	74/12/09	.294	1.1	0.1	50	.189
STORET #00915	Calcium, Milligrams/liter, No Standard						
Carr Fork near Sassafras	75/01/28	75/12/17	29.8	51.0	17.0	9	13.3
	70/07/07	74/12/17	29.7	57.0	7.7	41	11.3
North Fork Kentucky River at Hazard	70/11/03	72/10/15	60.0	72.0	38.0	3	19.1
	68/10/13	72/10/15	73.4	131.0	38.0	5	35.0
Red River near Pine Ridge	75/01/21	75/10/21	10.2	16.0	6.3	8	3.7
	74/10/01	74/12/16	12.2	15.0	9.4	2	3.96
	71/01/13	74/07/08	9.4	16.0	3.5	36	3.54
	69/08/08	70/11/04	12.0	17.0	5.1	13	3.58
	69/03/20	69/06/05	9.3	11.0	7.5	2	2.47
Kentucky River Lock 4	70/10/07	72/10/21	46.3	50.0	42.0	3	4.04
	68/12/11	72/10/21	50.4	47.0	42.0	5	6.27
	59/10/25	72/10/21	36.7	57.0	21.0	19	11.1
Kentucky River Lock 2	75/01/07	75/12/04	33.4	40.0	27.0	12	4.70
	73/02/07	74/12/09	34.6	47.0	15.0	24	6.34
Eagle Creek at Glencoe	75/01/30	75/12/18	64.8	94.0	46.0	9	15.8
	70/08/06	74/12/09	60.3	88.0	29.0	47	14.4
	62/01/24	74/12/09	59.6	88.0	29.0	49	14.7
STORET #00925	Magnesium, mg/l, No Standard						
Carr Fork near Sassafras	75/01/28	75/12/17	11.7	18.0	6.4	9	4.25
	70/07/07	74/12/17	11.7	22.0	3.5	41	3.60
North Fork Kentucky River at Hazard	70/11/03	72/10/15	25.3	29.0	20.0	3	4.73
	68/10/13	72/10/15	24.0	29.0	20.0	5	3.87
Red River near Pine Ridge	75/01/21	75/10/21	2.9	3.7	2.2	8	.504
	74/10/01	74/12/16	2.9	3.5	2.3	2	.894
	71/01/13	74/07/08	3.2	5.8	1.7	36	.922
	69/08/08	70/11/04	3.9	5.3	2.8	13	.766
	69/03/20	69/06/05	3.8	4.7	2.8	2	1.34
Kentucky River Lock 4	70/10/07	72/10/21	13.0	14.0	11.0	3	1.73
	68/12/11	72/10/21	12.6	14.0	11.0	5	1.34
	59/10/25	72/10/21	7.5	14.0	3.1	19	3.38

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00618	Nitrate - N mg/l, Prop. EPA Standard 10 mg/l						
Carr Fork near	75/01/28	75/12/17	.22	.43	.01	9	.157
Sassafras	71/10/19	74/12/17	.41	4.5	.00	29	.814
North Fork Kentucky							
at Hazard	71/10/18	73/09/15	.54	2.2	.10	50	.329
Red River near							
Hazel Green	72/09/12	72/09/12	1.1			1	
Red River near	75/01/21	75/12/03	.21	.39	.06	9	.106
Pine Ridge	74/10/01	74/12/16	.18	.31	.05	2	.184
	71/10/27	74/07/08	.15	.50	.00	28	.138
Kentucky River Lock 4	71/10/06	73/09/26	.70	1.2	.40	49	.189
Eagle Creek at Glencoe	75/01/30	75/12/18	.35	.66	.01	8	.224
	71/10/14	74/12/09	.40	1.1	.00	33	.351
STORET #00950	Fluoride mg/l Prop. EPA Standard 10 mg/l						
Carr Fork near	75/01/28	75/12/17	.23	.70	.00	9	.200
Sassafras	70/07/07	74/12/17	.16	.40	.00	41	.084
North Fork Kentucky	70/09/16	73/03/30	.45	3.7	.10	12	1.02
River at Hazard	68/10/13	73/03/30	.41	3.7	.10	14	.947
Red River near							
Hazel Green	70/10/02	72/09/12	.10	.10	.10	3	.00
Red River near	75/01/21	75/10/21	.24	.80	.00	8	.262
Pine Ridge	74/10/01	74/12/12	.05	.10	.00	2	.071
	71/01/13	74/07/08	.13	.40	.00	36	.091
	69/08/08	70/11/04	.09	.20	.00	13	.064
	69/03/20	69/06/05	.20	.20	.20	2	.00
Kentucky River Lock 4	70/10/07	72/10/21	.17	.30	.10	6	.082
	67/07/27	72/10/21	.18	.30	.10	9	.067
	59/10/25	72/10/21	.21	.40	.10	18	.073
Kentucky River Lock 2	75/01/07	75/12/04	.20	.50	.10	12	.121
	73/02/07	74/12/09	.20	.40	.00	24	.100

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Kentucky River Lock 2	75/01/07	75/12/04	6.6	8.4	5.4	12	1.08
	73/02/07	74/12/09	6.4	11.0	3.9	24	1.57
Eagle Creek at Glencoe	75/01/30	75/12/18	11.4	21.0	6.8	9	4.16
	70/08/06	74/12/09	8.7	20.0	4.2	47	3.25
	62/01/25	74/12/09	8.5	20.0	4.2	49	3.3
STORET #01025	Cadium, micrograms/liter, Kentucky Standarg, 100 ug/l						
North Fork Kentucky River at Hazard	75/03/20	75/06/17	.33	1.0	.00	3	.577
	74/04/16	74/10/03	1.25	4.0	.00	4	1.89
	63/10/25	74/10/03	.50	4.0	.0	10	1.27
Red River near Hazel Green	75/07/08	75/08/19	.5	1.0	.00	2	.707
Kentucky River Lock 4	75/01/22	75/04/21	.67	1.0	.00	3	.577
	74/03/11	74/09/30	1.0	6.0	.00	7	2.24
	62/11/12	74/09/30	.411	6.0	.00	17	1.46
Kentucky River Lock 2	75/01/07	75/10/08	1.25	2.0	.00	4	.957
	73/04/17	74/10/11	1.8	7.0	.00	8	2.25
Eagle Creek at Glencoe	75/06/06	75/06/06	.00			1	
	74/03/16	74/12/09	2.7	7.0	.00	6	2.58
STORET # 01056	Manganese, micrograms/liter Prop. Standard 50 ug/l						
Carr Fork near Sassafras	75/01/28	75/12/17	343.3	500.0	150.0	9	103.1
	71/10/19	74/12/17	354.0	1200.0	6.0	28	218.4
North Fork Kentucky River at Hazard	74/04/16	74/04/16	83.0			1	
Red River near Pine Ridge	75/01/21	75/10/21	20.4	36.0	7.0	8	10.8
	74/10/01	74/12/16	30.0	50.0	10.0	2	28.3
	71/01/13	74/05/28	29.3	110.0	.00	32	24.8
	69/08/08	70/11/04	52.8	180.0	.00	12	56.7
	69/03/20	69/06/05	46.7	60.0	20.0	3	23.1
Kentucky River Lock 4	75/04/21	75/04/21	40.0			1	
Kentucky River Lock 2	75/01/07	75/10/08	6.0	10.0	.00	4	4.90
	73/04/17	74/10/11	19.5	43.0	.00	8	15.9

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Eagle Creek at Glencoe	75/01/30	75/12/18	14.0	40.0	.00	9	11.5
	71/10/14	74/12/09	32.5	180.0	.00	32	37.4
STORET #01046	Iron, micrograms/liter, EPA Standard 300 u g/l						
Carr Fork near Sassafras	75/01/28	75/12/17	30.0	90.0	.00	9	30.4
	71/10/19	74/12/17	134.6	860.0	.00	28	222.8
North Fork Kentucky River at Hazard	74/04/16	74/04/16	10.0			1	
	65/01/07	74/04/16	65.8	450.0	.00	19	116.6
	64/12/01	74/04/16	76.7	450.0	.00	21	116.5
Red River near Pine Ridge	75/01/21	75/10/21	83.7	210.0	.00	8	65.2
	74/10/01	74/12/16	150.0	220.0	80.0	2	99.0
	71/01/13	74/05/28	147.0	440.0	.00	33	102.1
	69/08/08	70/11/04	183.3	410.0	90.0	12	100.7
	69/03/20	60/06/05	140.0	300.0	40.0	3	140.0
Kentucky River Lock 4	75/04/21	74/04/21	10.0			1	
Kentucky River Lock 2	75/01/07	75/10/08	5.0	20.0	.00	4	10.0
	73/04/17	74/10/11	38.7	90.0	.00	8	36.4
Eagle Creek at Glencoe	75/01/30	74/12/18	67.8	210.0	10.0	9	59.3
	71/10/14	74/12/09	95.6	280.0	10.0	32	66.2
STORET #01030	Chromium, micrograms/liter, EPA Stantard 300 ug/l						
North Fork Kentucky River at Hazard	75/03/20	75/06/17	.33	1.0	.00	3	.577
	74/04/16	74/10/03	.25	1.0	.00	4	.500
Red River near Hazel Green	75/07/08	75/08/19	.00	.00	.00	2	.00
Kentucky River Lock 4	75/01/22	75/04/21	1.3	4.0	.00	3	2.31
	74/03/11	74/09/30	1.9	10.0	.00	7	3.63
Kentucky River Lock 2	75/01/07	75/10/08	.50	1.0	.00	4	.577
	73/04/17	74/10/11	.286	1.0	.00	7	.488
Eagle Creek at Glencoe	75/06/06	75/06/06	1.0			1	
	74/03/16	74/12/09	.67	1.0	.00	6	.516

Table H-9
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #01049	Lead, micrograms/liter, Kentucky Standard 50 μg/l						
North Fork Kentucky River at Hazard	75/03/20	75/06/17	3.3	6.0	.00	3	3.06
	74/04/16	74/10/03	1.7	3.0	.00	3	1.53
	63/10/25	74/10/03	.556	3.0	.0	9	1.13
Red River near Hazel Green	75/07/08	75/08/19	5.0	7.0	3.0	2	2.83
Kentucky River Lock 4	75/01/22	75/04/21	4.0	8.0	1.0	3	3.61
	74/03/11	74/09/30	8.0	20.0	1.0	7	6.30
	62/11/12	74/09/30	3.3	20.0	0.	17	5.60
Kentucky River Lock 2	75/01/07	75/10/08	1.5	3.0	.00	4	1.73
	73/04/17	74/10/11	3.88	6.0	1.0	8	1.73
Eagle Creek at Glencoe	75/06/06	75/06/06	2.0			1	
	74/03/16	74/12/09	10.2	32.0	.00	6	12.6
STORET #01000	Arsenic, micrograms/liter, Kentucky Standard 50 μg/l						
North Fork Kentucky River at Hazard	75/03/20	75/06/17	.33	1.0	.00	3	.577
	74/04/16	74/10/03	.00	.00	.00	4	.000
	63/10/25	74/10/03	.56	3.0	.0	9	1.13
Red River near Hazel Green	75/07/08	75/08/19	.00	.00	.00	2	.00
	75/07/08	75/08/19	.00	.00	.00	2	.00
Kentucky River Lock 4	75/01/22	75/04/21	.33	1.0	.00	3	.577
	74/03/11	74/09/30	2.6	12.0	.00	7	4.39
	62/11/12	74/09/30	1.06	12.0	.0	17	3.00
Kentucky River Lock 2	75/01/07	75/10/08	.00	.00	.00	4	.00
	73/04/17	74/10/11	2.0	4.0	.00	8	1.60
Eagle Creek at Glencoe	74/06/06	75/06/06	1.0			1	
	74/03/16	74/12/09	1.2	2.0	.00	6	.753

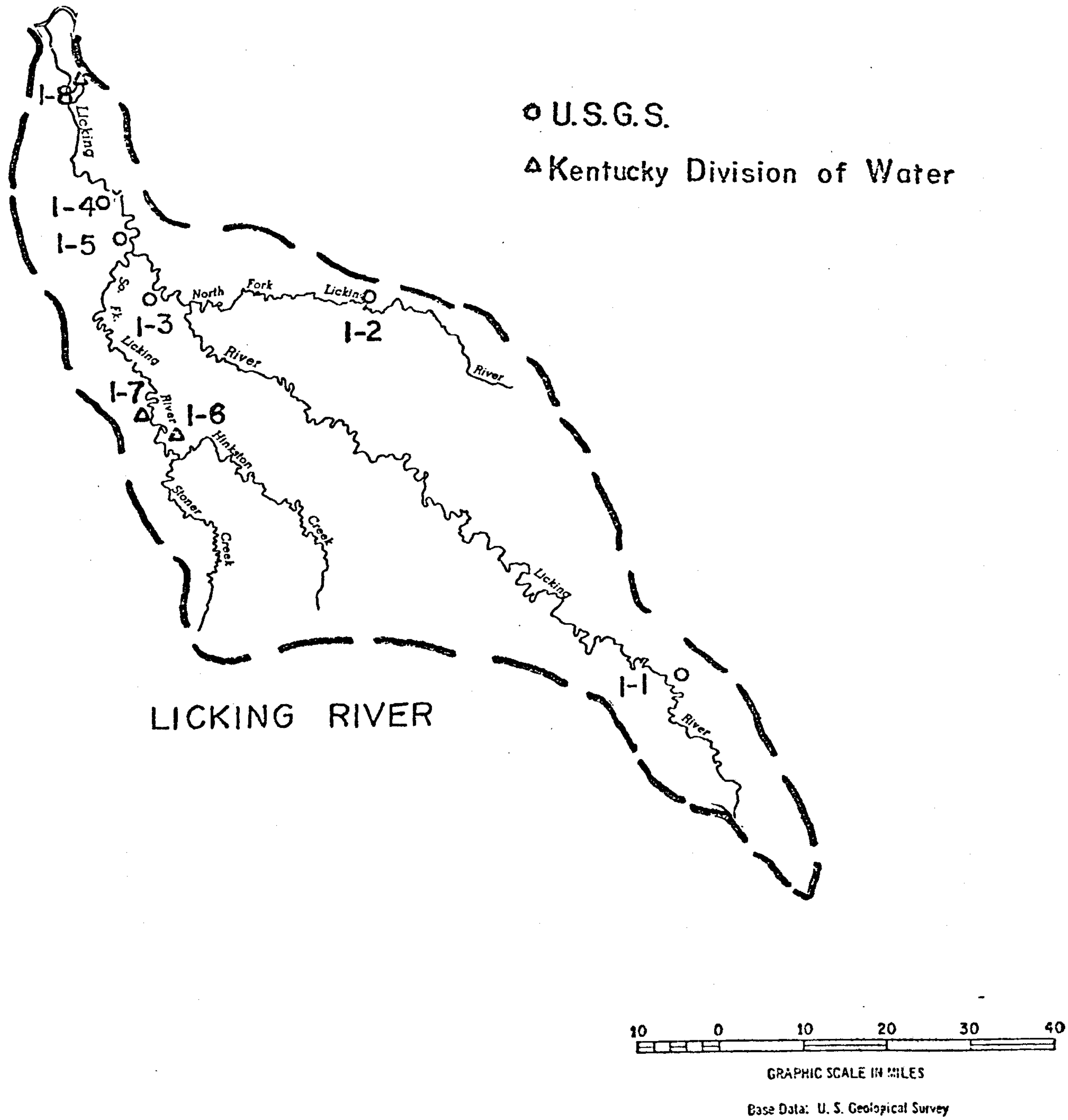
Bacteriological Data

Total Coliform colonies per 100 ml. STORET #31503 Kentucky Standard 1,000/100 ml
Fecal Coliform colonies per 100 ml. STORET #31616

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.
North Fork Kentucky River, Hazard						
Total Coliform	75/02/12	75/11/17	9160	31000	0	11
Fecal Coliform	75/02/12	75/08/13	770	1515	50	7

Table H-9
Bacteriological Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
Kentucky River, Richmond WPI							
Total Coliform	75/01/21	75/12/23	409	1600	0	11	
	74/04/15	75/12/23	665	7000	0	22	
Fecal Coliform	75/09/10		70			1	
	74/09/24	75/09/10	28	70	0	4	
Kentucky River, Lexington WPI							
Total Coliform	75/01/21	75/12/23	476	1600	41	12	
	74/04/15	75/12/23	469	1600	20	22	
Fecal Coliform	75/07/22	75/12/18	16	30	0	3	
Dix River, Danville WPI							
Total Coliform	75/01/30	75/12/17	322	1600	0	12	
	74/04/15	75/12/17	267	1600	0	23	
Fecal Coliform	74/09/24	74/11/26	10	30	0	3	
Kentucky River, Lock #8							
Total Coliform	75/01/21	75/12/23	554	1600	4	11	
	74/04/15	75/12/23	546	2050	4	22	
Fecal Coliform	74/09/24	75/09/10	31	96	0	4	
Kentucky River, Frankfort WPI							
Total Coliform	75/07/31	75/12/17	2788	11000	115	6	
	74/04/30	75/12/17	25778	180000	115	14	
Fecal Coliform	75/08/26	75/12/17	1622	6700	200	5	



U.S.G.S.
Kentucky Division of Water
I-8
Licking
I-4
I-5
So. Fk. Licking River
North Fork Licking
I-3
I-2
River
River
I-7
I-6
Hinkston Creek
Stoner Creek
Licking
I-1
River
LICKING RIVER
10 0 10 20 30 40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

THE LICKING RIVER BASIN

This report is in three parts. The first is a general basin description, the second describes the water quality, and the third part summarizes the problems and offers some general solutions.

I. A Description of the Licking River Basin

A. Geography

The Licking River Basin is located entirely within the eastern portion of the Commonwealth of Kentucky. The Licking River rises in southeastern Kentucky and flows northwesterly to its confluance with the Ohio River, opposite Cincinnati, Ohio. The total drainage area of the basin is 3,700 sq. mi. which is approximately 9 per cent of the land area of the state and includes all or portions of 21 counties. The basin is shaped much like an elongated diamond with an axis of about 130 miles and a minor axis of about 60 miles. The main stem is approximately 320 miles long.

The basin extends from Covington and Newport, Kentucky in the north, to below Salyersville in the south and from beyond Flemingsburg and Morehead in the east to Winchester in the west.

B. Topography

The Licking River drainage area is entirely south of the glaciated portion of the Ohio River Basin and physical features of the basin are generally the result of geological strata exposed by differential erosion following the broad uplift of the Paleozoic Era known as the Cincinnati Arch. The Licking River Basin exhibits four distinct physiographic types. The river rises in the Eastern Coal Fields of the Kanawha section of the (1) Appalachian Plateau, which has narrow ridges and crooked steep sided valleys. It flows through the (2) Knobs and the (3) Outer Blue Grass Regions. The South Fork drains a portion of the (4) Inner Blue Grass region of the Interior Low Plateau. The Knobs is an area of conical hills with rather broad valleys. The Outer Blue Grass is rather gently rolling except where the streams have entrenched themselves into deep valleys. The Inner Blue Grass region is gently rolling upland. There are no natural lakes in the basin. The generally flat topography of the Licking River Basin allows little reaeration due to the slope of the streams. Reaeration is the replacement of dissolved oxygen from the atmosphere which is used to stabilize organic matter. The river courses from an elevation of 998 ft. mean sea level (m.s.l.) at its headwaters to an elevation of 420 ft. m.s.l. at the confluence with the Ohio River for some 320 miles. The main stem has an average slope of approximately 1.9 ft./mi. Over the low half of the river the average slope is 1.3 ft./mi. The slopes of the tributaries average between 1 to 2 ft./mi. for the North and South Forks and into the hundreds of feet per mile in some of the smaller tributaries. A slope in the range of 0 to 2 ft./mi. is considered low, 2 to 6 ft./mi. is moderate and 6 to 10 ft./ mi. is high as it relates to the effect of reaeration.

C. Geology

The major geologic influence on the quality of the water in the Licking River Basin is the occurance of limestone throughout the basin. Limestone contributes calcium and magnesium through solution from the soil and rocks which imparts hardness to the water. The coal field does not appear to be having a significant effect on water quality at this time.

The groundwater resources are limited by the low yield of the aquifers in the basin, thus restricting the use of groundwater as a major source of water supply.

D. Hydrology

During the late summer and early autumn, portions of the Licking River have flows of less than 5 cubic feet per second (Table I-2). Such low flows severly limit the capacity of a stream to maintain the standard of 5 mg/l of dissolved oxygen. Cave Run Reservoir near Farmers, Kentucky, 174 miles from the mouth, was built to store 47,000 acre feet of water for hood control, water supply recreation and low flow augmentation. Cave Run Reservoir is designed to augment the low flow in the Licking River by 50 cubic feet per second (c.f.s.).

E. Population

The population of the Licking River Basin was 211,000 in 1970. The distribution throughout the basin is fairly uniform except for a major population center in Campbell and Kenton Counties, composing a part of the SMSA of Cincinnati, Ohio. Although Campbell and Kenton Counties don't discharge treated sewage into the Licking River, combined sewer overflow and street run-off do affect water quality in the lower Licking River. The total urban population of the basin is 106,000 or 50 per cent of the whole basin. The other 50 per cent is in rural areas.

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TABLE I-2

SURFACE WATER RECORDS FOR THE LICKING RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Licking River at Farmers **	37 yr.	827 sq.mi.	1,073 cfs, 1.3cfs*/sq.mi.	24,000 cfs, 29cfs/sq.mi.	0.7 cfs, 0.0cfs/sq.mi.	54.4 cfs
	wtr/yr 1975		1,556 cfs, 1.9cfs/sq.mi.	4,020 cfs, 5cfs/sq.mi.	66 cfs, 0.1cfs/sq.mi.	
South Fork Licking River at Cynthiana	37 yr.	621 sq.mi.	763 cfs, 1.2cfs/sq.mi.	35,300 cfs, 57cfs/sq.mi.	0.3 cfs, 0.0cfs/sq.mi.	0.9 cfs
	wtr/yr 1975		1,087 cfs, 1.8cfs/sq.mi.	18,000 cfs, 29cfs/sq.mi.	5.7 cfs, 0.0cfs/sq.mi.	
Licking River at Catawba **	49 yr.	3,300 sq.mi.	4,156 cfs, 1.3cfs/sq.mi.	95,000 cfs, 29cfs/sq.mi.	2.5 cfs, 0.0cfs/sq.mi.	62 cfs
	wtr/yr 1975		5,938 cfs, 1.8cfs/sq.mi.	52,100 cfs, 16cfs/sq.mi.	203 cfs, 0.1cfs/sq.mi.	

* Cubic feet per second

** Flow regulated since December, 1973 by Cave Run Lake.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

II. Basin Water Quality

The water quality of the Licking River Basin has been determined by using both a computer model and data collected at three monitoring stations. These sources give an overall picture of the basin which shows problems caused by sewage treatment plant effluent and erosion.

A. Description of Sampling Stations

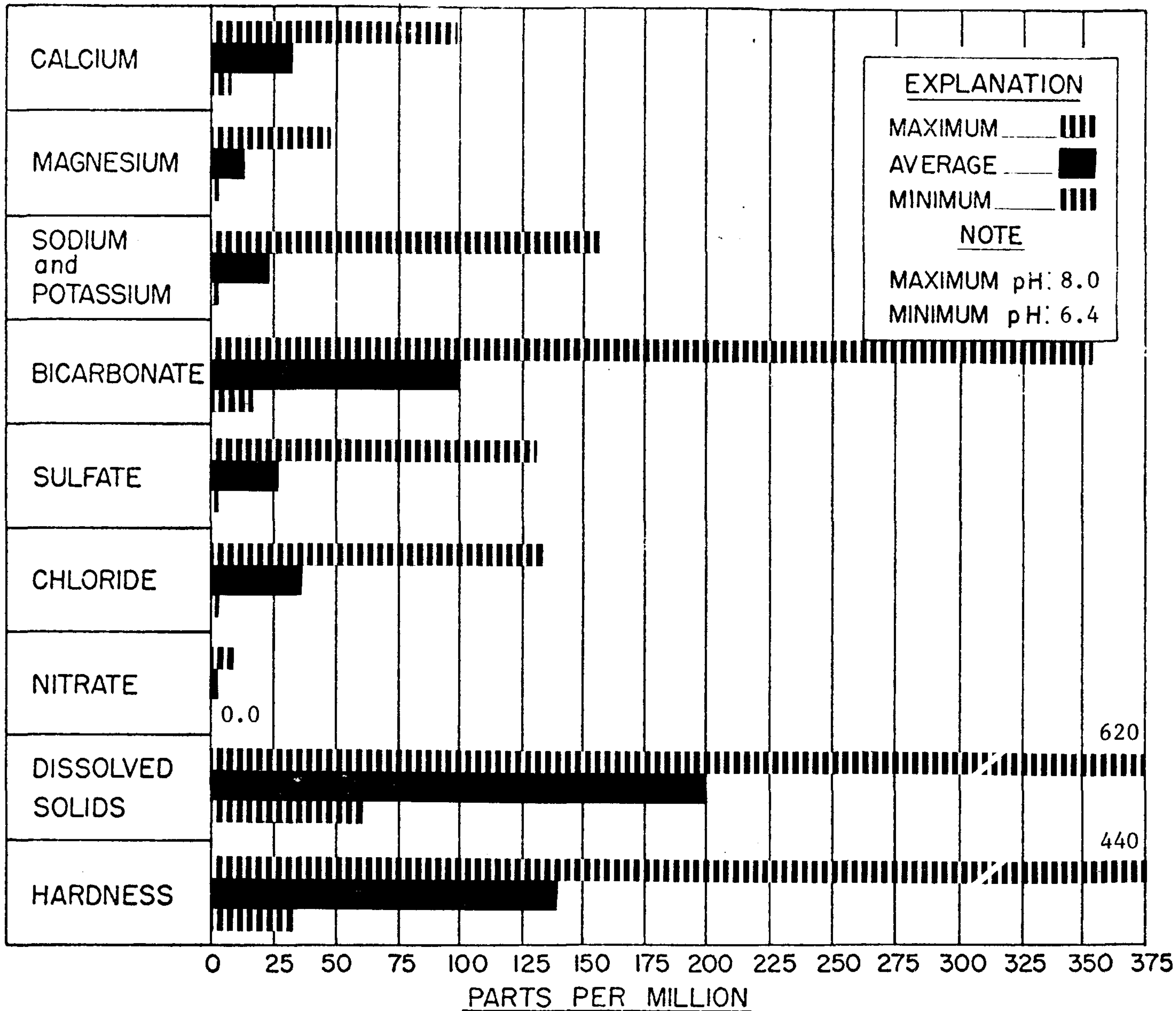
The Salyersville monitoring station, the farthest upstream of the three stations, is on the Licking River 1.2 miles west of Salyersville and 266 miles from the mouth. The drainage area at this point is 140 sq. mi.

The second station, at McKinneysburg, on the Licking River is 64 miles from the mouth and has a drainage area of 2,300 sq. mi.

The last station is at the Kenton County water intake on the Licking River approximately 2 miles from the mouth at the Ohio River. The drainage area at this station is approximately 3,700 sq. mi.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is of moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.



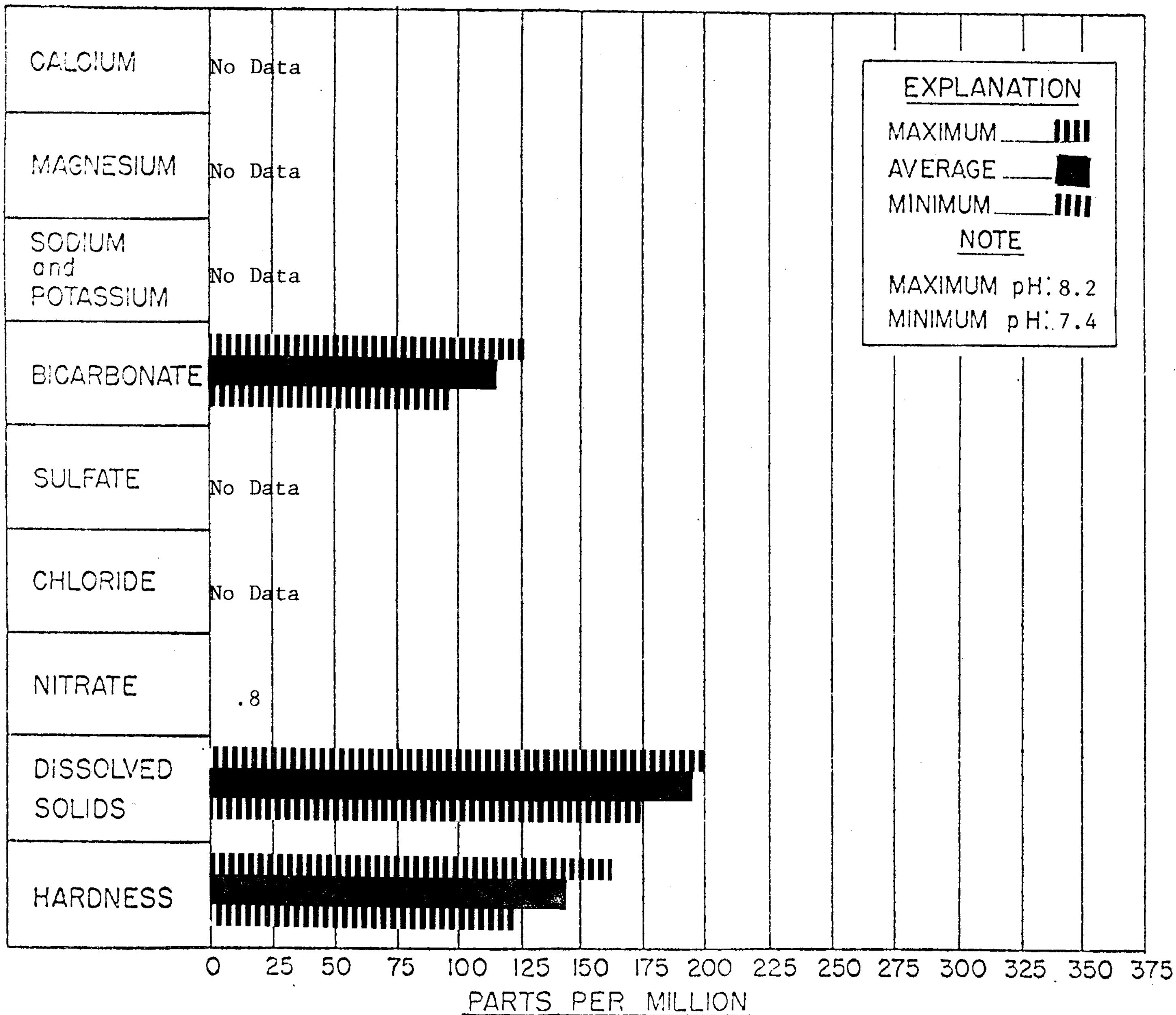
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE I-1

Licking River

Salyersville

5-65 to 11-74

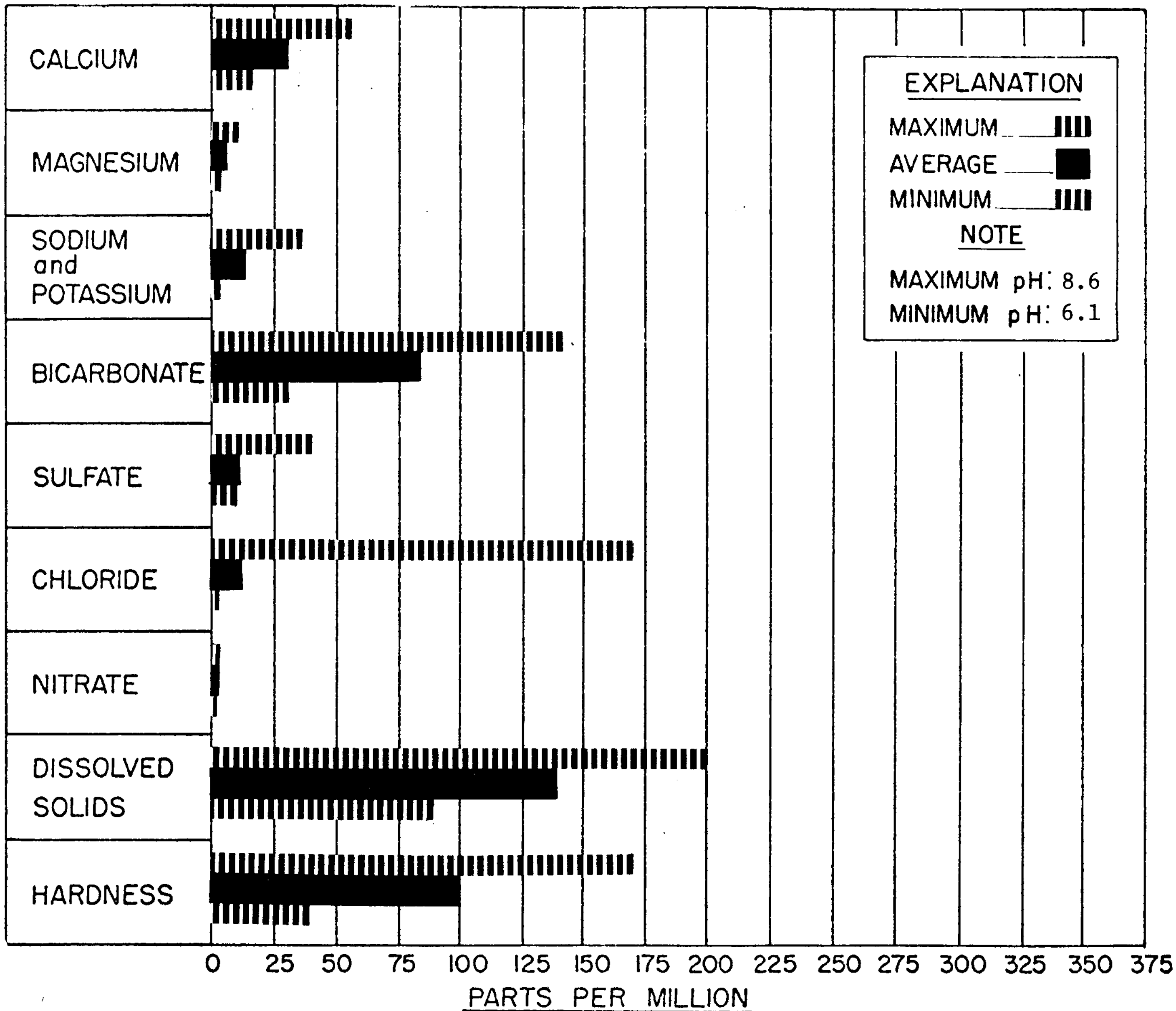


MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE I-2

North Fork Licking River

9-70 to 8-72



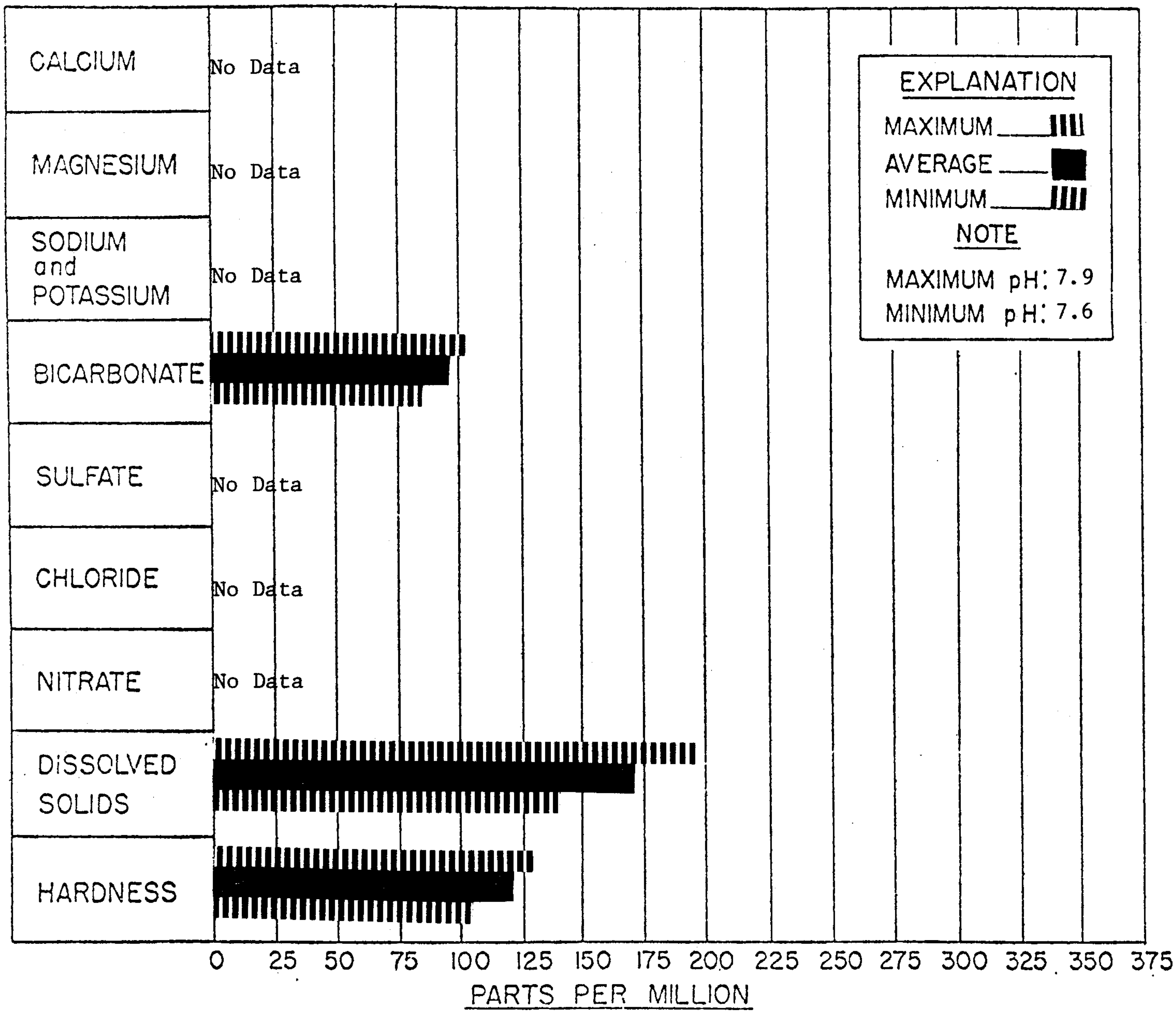
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE I-3

Licking River

McKinneysburg

10-59 to 10-73



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents

FIGURE I-4

Licking River

Catawba

1962 to 1974

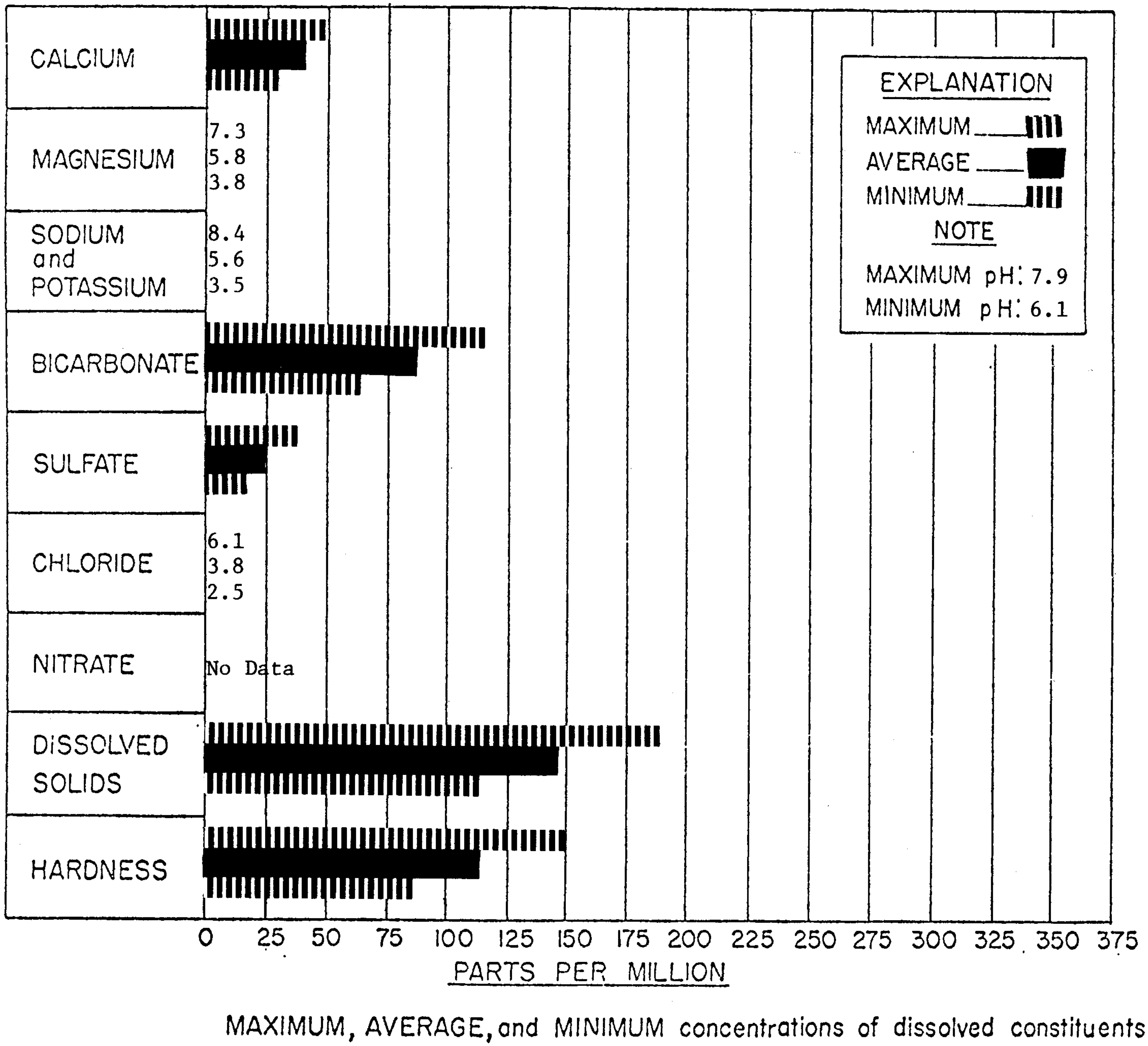


FIGURE I-5

Licking River

Butler

10-74 to 12-75

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20-25 parts per million as an average value.

Two sampling stations which were used to depict the general chemical water quality for the Licking River basin reflect two different situations on the river.

Salyersville was selected to determine the effect of coal mining on water quality. This station is near the headwaters and above Cave Run Reservoir, and shows a wide variation in chemical quality partly due to the relatively small drainage area. That area is totally within the eastern coal field and fluctuations at the Salyersville station indicate the effects of coal mining and oil field operations on water quality. The effect of coal mining and oil field productions is illustrated principally in Figure I-1. The extreme variation in all parameters in comparing the average to the maximum indicates the influence of sporadic discharges which impacts water quality primarily at low flow periods. The production of coal in the Licking River Basin is low as compared to the Coal reserves. Oil field production is primarily limited to recharge well production which is limited. Both of these developments reflect the primary influence of water quality, particularly at times of low flow, since the average values are much as would be expected without oil or coal production. Figure I-4 indicates that the water is typical of Kentucky stream water when looking at the average values.

McKinneysburg, another station, was selected to indicate general chemical water quality of the majority of the drainage basin (62%) and the effects of Cave Run Reservoir as compared with the Salyersville station.

The water is classified as soft, moderately hard, hard, and very hard due to the concentration of certain ions. primarily calcium and magnesium. The range of hardness is 121 mg/l + 180 mg/l with an average of 136 which is hard water.

The impact on water quality from Cave Run Reservoir at McKinneysburg is clearly illustrated by comparing the graphs of McKinneysburg and Salyersville. All parameters decrease at McKinneysburg which demonstrates the effectiveness of water reservoir impoundments for quality control of the general chemical quality of water and the ability of a reservoir to iron out or stabilize imparted chemical quality from the exploration of mineral resources such as coal and iron field developments.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

The trace chemicals results were from samplings at the Kenton County water district and in the Licking River Basin the water quality falls within the Kentucky-Federal Water Quality Standards.

D. Waste Load Effects on Water Quality

Biochemical degradable wastes impose a load on the dissolved oxygen resources of a stream. Such waste loads are considered to have an adverse effect on water quality when they cause the dissolved oxygen concentration of the water to drop below the Kentucky water quality standard of 5.0 mg/l. Approximately 1,000 miles of stream length were studied using a model to determine waste load allocations. The model was developed in the Kentucky Continuing Planning process for River Basin Management Planning. Using this model it was determined that approximately 384 miles are affected by treated wastewater. Of the 384 miles 46 miles are affected by industry, 89 miles by municipal sewage treatment plants and 249 miles are affected by other sources such as schools, trailer parks, motels, etc.

E. Non-Point Source Effects

Major non-point source pollution problems in the Licking River Basin include sediment from agricultural erosion, field gullies, streambank erosion, roadbank erosion, and erosion from soil disturbances during development of areas for commercial, residential, and industrial purposes. The following estimates were obtained from Soil Conservation Survey of U. S. Department of Agriculture.

Erosion from about 78 sq. mi. of cropland contributes an estimated 57% of the total annual sedimentation entering the stream system.

It is estimated that over 24% of the sediment entering the Licking River annually is a result of erosion from construction sites. The source is concentrated in the lower section of the basin.

Approximately 5.5 sq. mi. of field gullies have a potential for producing 10% of the annual sedimentation.

Streambank erosion is severe on about 400 miles in the basin, with a potential for producing over 7% of the sediment annually.

Approximately 170 miles of critical roadbank erosion have the potential for producing 2% of the sediment annually.

F. Water Uses

The major use of water in the Licking River Basin is industrial. An estimated 18 million gallons per day (m.g.d.) are used by industries while 9 m.g.d. are used for public consumption. Kenton County Water District #1 withdraws approximately 50% of the total public withdrawal and Interlake Steel Corporation withdraws approximately 80% of the industrial total. A complete breakdown can be found in Table I-6.

The Licking River is a well known Kentucky fishing stream. Throughout much of the basin high quality fish can be taken including "muskie" and bass. Cave Run Reservoir offers even more opportunity for recreational activities, and the area is now being developed to include more boating and swimming facilities.

The primary use of water in the basin for agriculture is livestock watering. The water quality doesn't limit the use for other agricultural practices but rather the usually abundant rainfall provides a more than adequate amount of water without supplementation from streams.

III Summary

The water quality as indicated by the Salyersville, McKinneysburg and Kenton County gauging stations appears to be good. Salyersville is particularly good even though it is in a mining area and McKinneysburg is even better due to the larger drainage area and the buffering action of Cave Run Reservoir.

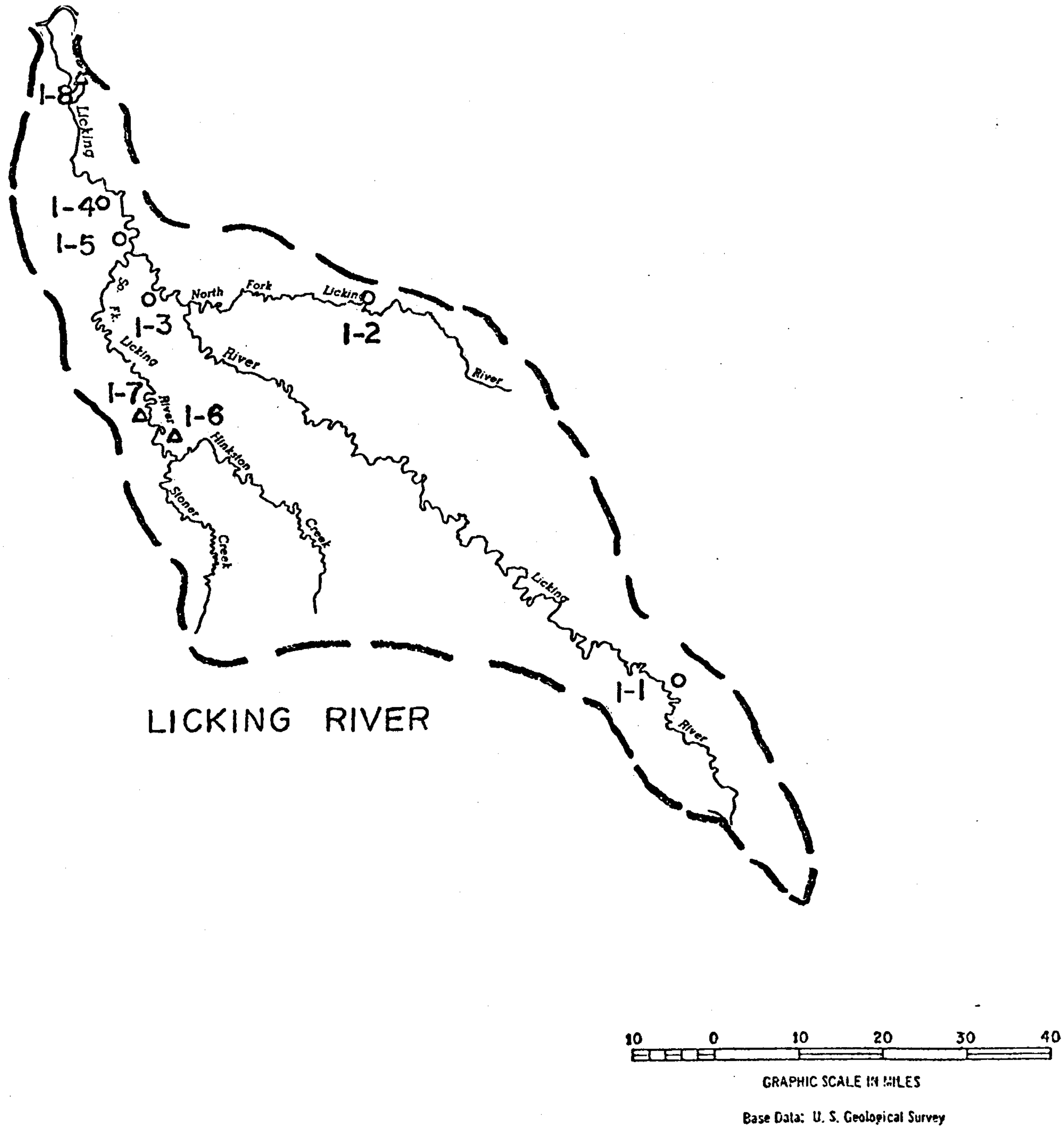
The two problem areas that presently need the most attention in the Licking River Basin are erosion with subsequent siltation, and possible stream degradation due to sewage treatment plant effluent.

Both problems lend themselves to easy statements for solutions; such as better land use management for control of erosion and upgrading sewage treatment facilities for both the private and public sectors.

The majority of the siltation comes from cultivated fields. Much of the Licking River Basin is in an agricultural area and the implementing of farming practices to prevent soil erosion is needed. The real possibility of a threefold increase in coal mining in Kentucky also raises the prospect of increased siltation and acid mine drainage. The coal fields in the Licking River Basin are relatively undeveloped and the trend to increased coal mining can pose a serious threat to the basin's water quality. Present and possible future federal and state legislation controlling mining practices will be needed if the integrity of water quality is to be maintained.

The sewage treatment plant effluent problem is very complex. Upgrading of existing facilities is underway in both the construction and planning phases. Numerous small "package" treatment plants still dot the countryside. The effluent from these plants is often of inadequate quality to protect the receiving stream. This large number and relatively small size make operation and enforcement difficult. Either an improvement in the design of "package" treatment plants or running sewers from these outlying areas to central sewage treatment plants is needed to protect the small tributaries.

Neither of the above mentioned problems are peculiar to the Licking River Basin in Kentucky. Their solution will most likely be a part of the statewide implementation of the 303e River Basin Planning Process and other related programs.



1-8
Licking
1-4
1-5
So.
Ft.
Licking
1-3
North
Fork
Licking
1-2
River
River
1-7
River
1-6
Hinkston
Stoner
Creek
Creek
Licking
1-1
River
LICKING RIVER
10
0
10
20
30
40
GRAPHIC SCALE IN MILES
Base Data: U. S. Geological Survey

STATION KEY

I-1 LICKING RIVER AT SALYERSVILLE
I-2 NORTH FORK LICKING RIVER
I-3 LICKING RIVER AT McKINNEYSBURG
I-4 LICKING RIVER AT BUTLER
I-5 LICKING RIVER AT CATAWBA
I-6 LICKING RIVER AT PARIS
I-7 LICKING RIVER AT CYTHIANA
I-8 LICKING RIVER AT KENTON Co. WATER PLANT INTAKE

Table I-1

Drainage Areas in the Licking River Basin

* a. Total Area in Square Miles 3707

b. Sub-basins over 200 square miles

Licking River Basin	3707 sq. mi.
1. North Fork Licking	308 sq. mi.
2. Slate Creek	230 sq. mi.
3. South Fork Licking	927 sq. mi.
a. Stoner Creek	284 sq. mi.
b. Hinkston Creek	260 sq. mi.

c. Area of Basin in each County**

			Total Sq. Mi.	Sq. Mi.*** in basin
1.	Bath	100 %	287	287
2.	Boone	1.9%	249	7
3.	Bourbon	100 %	300	300
4.	Bracken	44 %	204	90
5.	Campbell	44 %	149	65
6.	Clark	37 %	259	95
7.	Elliott	4 %	240	9
8.	Fleming	100 %	350	350
9.	Grant	36 %	249	91
10.	Harrison	100 %	308	308
11.	Kenton	86 %	165	143
12.	Lewis	8 %	486	39
13.	Magoffin	96 %	303	290
14.	Mason	62 %	238	147
15.	Menifee	62 %	210	131
16.	Montgomery	88 %	204	180
17.	Morgan	90 %	369	332
18.	Nicholas	100 %	204	204
19.	Pendleton	91 %	279	255
20.	Robertson	100 %	101	101
21.	Rowan	94 %	290	273

* <u>Drainage Areas in Kentucky</u>, Frankfort, Kentucky, December 20, 1974

** Area - U. S. Census - Source of measurement - Approximately ± 10%

*** Percent in Basin - Federal Water Pollution Control Administration - Ohio River Basin Framework Comprehensive Study

Table I - 3

City Population and Facility Grant Status
in the Licking River Basin in Kentucky

County	City	Population	Project Type	Comments
Bath	Owingsville	1,381	I	Underway
	Salt Lick	441	I	Pending
Bourbon	Paris	7,823	I	Underway
	Millersburg	788	I	Underway
	North Middletown	433	None	Sewered
Campbell	San. Dist. #2		None	Sewered
Clark	Winchester	13,402	I & III	Underway
Fleming	Flemingsburg	2,483	I	Underway
Grant	Williamstown	2,063	I	Underway
	Crittenden	359	None	No Sewers
	Corinth	236	None	No Sewers
Harrison	Cynthiana	6,356	I	Underway
	Berry	266	None	No Sewers
Kenton	Elsmere	5,161	None	Sewered
	Independence	1,784	None	No Sewers
Magoffin	Salyersville	1,196	I	Pending
Menifee	Frenchburg		None	Sewered
Montgomery	Mt. Sterling	5,083	I	Underway
			II	Pending

Table I - 3
Continued

Montgomery (con't)	San. Dist. #1		III	Underway
	San. Dist. #2		I	Underway
Morgan	West Liberty	1,387	None	Sewers
Nicholas	Carlisle	1,579	I	Underway
Pendleton	Falmouth	2,593	I	Underway
	Butler	558	None	Sewered
Robertson	Mt. Olivet	442	None	No Sewers
Rowan	Morehead	7,191	I	Underway
			II	Pending

Note: Project type is related to the type of grant applied for received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U. S. Census and the FY 75 construction grants list for Kentucky.

TABLE I-4

Population in the Licking River Basin by County

COUNTY	TOTAL POP. 1970	POP. IN BASIN
Bath	9,114	9,114
Boone	21,940	150
Bourbon	18,178	18,178
Bracken	7,422	2,400
Campbell	86,803	9,500
Clark	21,075	16,000
Elliott	6,330	200
Fleming	10,890	10,890
Grant	9,489	5,000
Harrison	13,704	13,704
Kenton	120,700	49,000
Lewis	13,115	900
Magoffin	11,156	10,000
Mason	18,454	7,000
Menifee	4,276	2,800
Montgomery	13,461	13,000
Morgan	11,056	9,100
Nicholas	6,677	6,677
Pendleton	9,949	9,400
Robertson	2,163	2,163
Rowan	17,010	16,000
		211,176

Table I-5

Organic Loads Affecting Streams in the Licking River Basin

Length of streams to which treated organic loads are discharged		1,000
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		384
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to	Municipal Discharges	89
	Industrial Discharges	46
	Other Discharges	249

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicated the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year, seven day, low flow.

TABLE I-6

WATER WITHDRAWAL IN THE LICKING RIVER BASIN

COUNTY	CREEK	SW *	GW **	PUBLIC	INDUSTRIAL
BATH					
Municipal Water & Sewer Service	Slate Creek	x		.150 MGD ***	
Sharpsburg Water District	Reservoir	x		.032 MGD	.003 MGD
BOONE					
Municipal Water Works Walton	Two Lakes	x		.098 MGD	
BOURBON					
Paris Municipal Water Works	Stoner Creek		x	.575 MGD	.530 MGD
Millersburg Municipal Water Works	Hinkston Creek	x		.105 MGD	.005 MGD
N. Middletown Municipal Water Works	Stoner Creek	x		.046 MGD	
CAMPBELL					
Interlake Steel Corporation	Licking River	x			14.9 MGD
FLEMING					
Flemingsburg Municipal Water Works	2 reservoirs	x		.107 MGD	.088 MGD
Western Fleming Water District, Ewing	Licking River	x		.206 MGD	.004 MGD
GRANT					
Williamstown Municipal Water Works	Lake Branch Res.	x		.173 MGD	.051 MGD
Corinth, Wm. O. Ratcliff	Reservoir	x		.013	
HARRISON					
Cynthiana Municipal Water Works	S. Fork of Licking River	x		.773	.515
Cynthiana, Joseph E. Seagram and Sons	S. Fk. Licking River & Well	x	x		.010 GW 1.250 SW

Continued - I-6

COUNTY	CREEK	SW	GW	PUBLIC	INDUSTRIAL
KENTON					
Kenton Co. Water Dist. #1 S. Fort Mitchell	Licking River	x		4.663	.047
MONTGOMERY					
Mt. Sterling Municipal Water Works	Slate Creek Res.	x		.235	.941
MORGAN					
West Liberty Municipal Water Works	Licking River	x		.175	
NICHOLAS					
Carlisle Municipal Water Works	Two Lakes	x		.230	.012
PENDLETON					
Falmouth Municipal Water Works	Licking River	x		.310	.020
Mago Construction Co. Inc. Bardstown	Licking River	x			.001
Butler Municipal Water Works	Licking River	x		.086	
ROBERTSON					
Mt. Olivet Municipal Water Works	Licking River	x		.030	
ROWAN					
Morehead State University	Evans Br. Res. S. Fk. Triplett Cr.	x		.548	.029
Morehead Utility Plant Board	Licking River	x		.412	.008
Tennessee Gas Pipeline Co. Morehead	N. F. Triplett Creek	x			.010
Morehead	Impoundment on Schoolhouse Br.	x			.001
			TOTAL	8.967	18.413

SW - Surface Water
GW - Ground Water
MGD - Million Gallons per Day

Table I-7

Water Quality Data in the Licking River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	OBS.	S
STORET #00400	pH Specific Units Kentucky Standard 1-LT pH-9						
Licking River	70/07/29	74/10/02	6.9	7.3	6.4	37	.214
Salyersville	65/05/19	74/10/02	6.9	7.3	6.4	38	.212
U.S.G.S. #03248500							
N. Fork Licking	70/09/23	72/08/15	7.8	8.2	7.4	3	.400
River LE							
U.S.G.S. #03251000							
Licking River	70/01/13	73/09/25	7.7	8.4	6.9	94	.342
McKinneysburg	65/01/13	73/09/25	7.6	8.6	6.6	212	.371
U.S.G.S. #03251500	59/11/03	73/09/25	7.6	8.4	6.1	268	.396
Licking River	75/01/08	75/12/03	7.1	7.9	6.1	12	.506
Butler	74/10/17	74/11/21	7.7	7.9	7.4	2	.354
U.S.G.S. #03254000							
Licking River	70/09/23	72/08/15	7.9	7.9	7.9	3	.008
Catawba	62/09/24	72/08/15	7.8	7.9	7.6	4	.150
U.S.G.S. #03253500							
STORET #00095	Conductivity Micro mhos, Ky. Std. 800 micro mhos						
Licking River	75/01/02	76/01/17	184.5	290.9	100.0	10	75.6
Saylersville	70/07/29	74/11/19	279.7	1170	102.0	44	201.2
	65/05/19	76/01/17	263.2	1170	100.0	55	186.1
N. Fork Licking	70/09/23	72/08/15	287.0	315.0	250.0	3	33.4
River LE							
Licking River	70/01/03	73/09/25	232.3	801.0	103.0	94	87.1
McKinneysburg	65/01/13	73/09/25	237.8	801.0	103.0	223	78.4
	59/10/07	73/09/25	238.4	801.0	102.0	368	76.6
Licking River	75/01/08	75/12/03	242.5	338.0	175.0	11	53.5
Butler	74/10/17	74/12/10	258.7	301.0	220.0	3	40.6
Licking River	70/09/23	74/08/23	235.3	264.0	212.0	6	22.8
Catawba	62/09/24	74/08/23	242.6	286.0	212.0	7	28.3

Table I-7
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	OBS.	S
STORET #70300	Dissolved Solids mg/l, Kentucky Standard 500 mg/l						
Licking River Salyersville	75/01/02	75/12/04	106.9	175.0	50.0	9	44.8
	70/97/29	74/11/19	166.8	722.0	65.0	44	120.7
N. Fork Licking River LE	70/09/23	72/08/15	190.0	200.0	174.0	3	14.0
Licking River McKinneysburg	70/01/03	75/10/09	142.7	490.0	64.0	94	53.6
	65/01/13	73/09/25	148.2	490.0	62.0	223	48.1
	53/10/26	73/09/25	143.7	490.0	62.0	423	42.6
Licking River Butler	75/01/08	75/10/09	137.7	182.0	113.0	10	21.0
	74/10/17	74/12/10	159.3	180.0	140.0	3	20.0
Licking River Catawba	70/09/23	72/08/15	177.7	194.0	138.0	3	30.3
STORET #00410	Alkalinity mg/l, No Standard						
Licking River Salyersville	75/01/02	75/12/04	38.4	86.0	13.0	9	25.8
	70/07/29	75/12/04	37.6	84.0	16.0	44	19.3
N. Fork Licking River LE	70/09/23	72/08/15	116.3	126.0	98.0	3	15.9
Licking River McKinneysburg	70/01/03	73/09/25	79.7	141.0	31.0	94	27.5
	65/10/07	73/09/25	82.0	141.0	31.0	171	26.3
Licking River Butler	75/01/03	75/10/09	82.9	104.0	63.0	10	12.6
	74/10/17	74/12/10	99.0	118.0	80.0	3	19.0
Licking River Catawba	62/09/24	72/08/15	95.8	103.0	82.0	4	9.9
STORET # 00900	Hardness mg/l, 0-6- Soft, 61-120 MOD, Hard, 121-180 Hard, 180 + Very Hard						
Licking River Salyersville	75/01/02	75/12/04	68	140	35	9	34.4
	70/07/29	74/11/19	72	200	32	44	34.9
	65/05/19	74/11/-	140	140	32	57	110
N. Fork Licking River LE	70/09/23	72/08/15	140.0	160.0	120.0	3	20.0

Table I-7
Continued

Station	Beg. Date	End Date	Mean	Max.	Min	OBS.	S
Licking River McKinneysburg	70/01/03	73/09/25	103.1	170.0	42.0	94	32.1
	65/01/13	73/09/25	106.3	171.0	42.0	213	31.8
	59/10/07	73/09/25	102.9	171.0	39.0	341	29.0
Licking River Butler	75/01/08	75/10/09	107.2	140.0	85.0	10	16.3
	74/10/17	74/12/10	130.0	150.0	110.0	3	20.0
Licking River Catawba	62/09/24	72/08/15	120.0	130.0	104.0	4	12.7
STORET #00915	Calcium mg/l, No Standard						
Licking River Salyersville	75/01/02	75/12/04	17.4	42.0	8.2	9	10.9
	70/07/29	74/11/19	18.9	56.0	7.4	44	10.2
Licking River McKinneysburg	70/10/17	72/10/31	38.0	51.0	30.0	3	11.4
	68/11/01	72/10/31	38.0	51.0	30.0	5	8.2
	59/11/03	72/10/31	31.4	55.0	16.0	23	9.3
Licking River Butler	75/01/08	75/10/09	34.1	44.0	26.0	10	5.0
	74/10/17	74/12/10	40.7	48.0	33.0	3	7.5
STORET #00925	Magnesium mg/l, No Standard						
Licking River Salyersville	72/01/02	75/12/04	5.9	8.6	6.1	3	1.9
	68/11/01	72/1031	6.1	14.0	1.9	44	2.5
Licking River McKinneysburg	70/10/17	72/10/31	7.0	7.6	6.1	3	.794
	68/11/01	72/10/31	7.6	9.5	6.1	5	1.2
	59/11/03	72/10/31	5.7	9.5	2.7	23	1.6
Licking River Butler	75/01/08	75/10/09	5.6	7.3	3.8	10	1.2
	74/10/17	74/12/10	6.5	7.3	5.6	3	.862
STORET #00618	Nitrate mg/l Proposed E.P.A. Std. 10 mg/l						
Licking River Salyersville	75/01/02	76/01/17	.27	.47	.06	9	.11
	71/10/14	74/11/19	.31	.63	.06	31	.15
N. Fork Licking River LE	72/08/15	72/08/15	0.8			1	

Table I-7
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	OBS	S
Licking River	71/10/05	73/09/25	0.72	1.5	0.01	49	.30
McKinneysburg	71/10/05	73/09/25	0.72	1.5	0.01	49	.30
Licking River Catawba	72/08/15	72/08/15	1.3			1	
STOREET #01000	Arsenic ug/l, Kentucky Std. 50 ug/l						
Licking River	75/01/02	75/03/24	0.0	0.0	0.0	3	0.0
Salyersville	74/04/01	74/11/19	2.5	8.0	0.0	4	3.7
	74/04/01	75/03/24	1.4	8.0	0.0	7	2.9
N. Fork Licking River LE	75/07/10	75/12/16	0.75	1.0	0.0	4	0.5
Licking River	65/01/02	65/09/30	0.0	0.0	0.0	9	0.0
McKinneysburg	63/10/29	65/09/30	0.0	0.0	0.0	23	0.0
Licking River Butler	75/01/08	75/10/09	0.0	0.0	0.0	4	0.0
Licking River	75/06/25	75/06/25	1.0			1	
Catawba	74/03/14	74/12/10	1.2	3.0	0.0	6	1.3
STORET #00950	Fluoride micrograms/liter, Kentucky Std. 1.0 ug/l						
Licking River	75/01/02	75/12/04	0.16	0.3	0.0	9	0.10
Salyersville	70/07/29	74/11/19	0.15	0.6	0.0	43	.11
N. Fork Licking River LE	70/09/23	72/08/15	0.2	0.3	0.1	3	0.1
Licking River	70/09/23	72/10/31	0.17	0.3	0.1	7	.08
McKinneysburg	68/11/01	72/10/31	0.17	0.3	0.1	9	.07
	59/11/03	72/10/31	0.18	0.4	0.1	22	.09
Licking River	75/01/08	75/10/09	0.19	0.3	0.0	10	0.1
Butler	74/10/17	74/12/10	0.23	0.4	0.1	3	.15
Licking River	70/09/23	72/08/15	0.23	0.3	0.1	3	.12
Catawba	62/09/24	72/08/15	0.2	0.3	0.1	4	0.1
STORET #01025	Cadmium micrograms/liter, Kentucky Std. 100 ug/l						
Licking River	75/01/02	75/03/24	0.33	1.0	0.0	3	.58
Salyersville	74/04/01	74/11/19	5.8	18.0	1.0	4	8.2

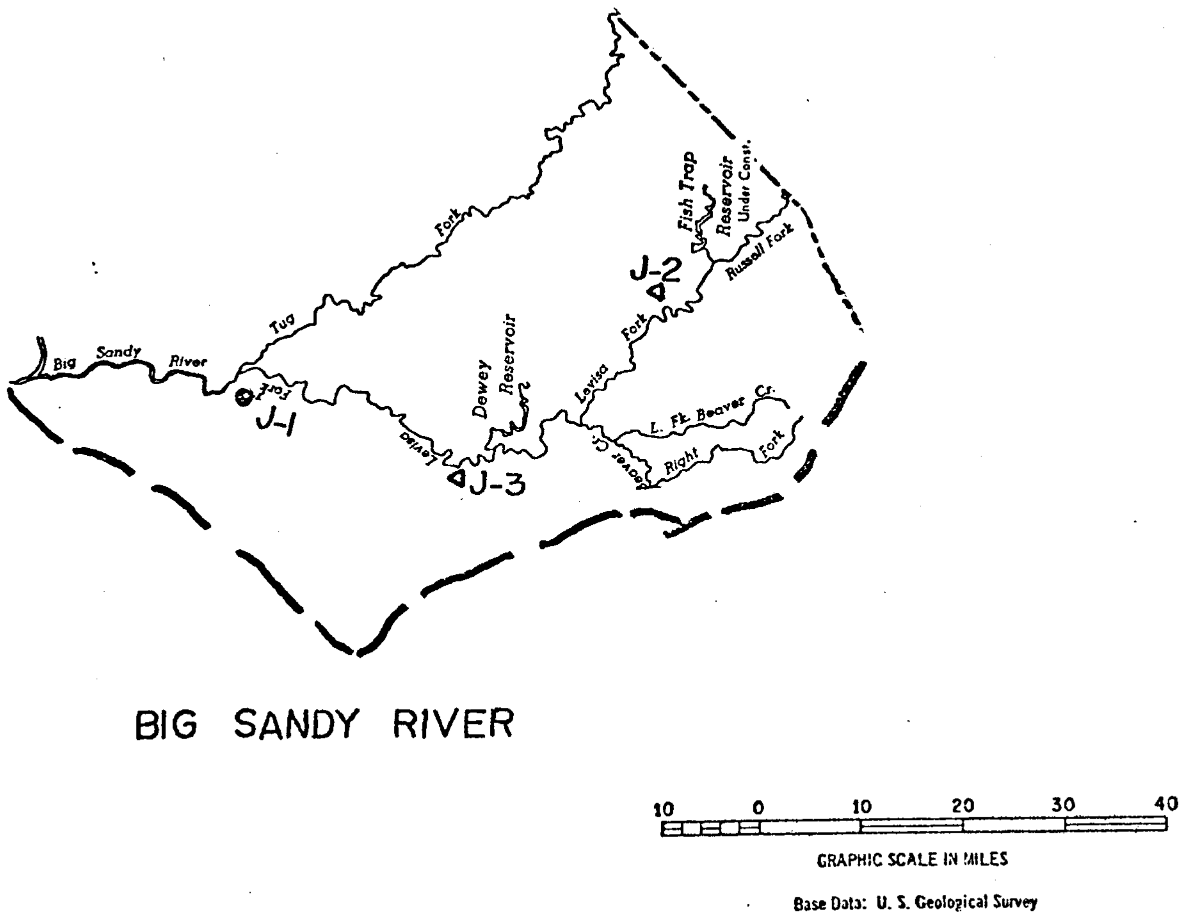
Table I-7
Continued

Station	Beg. Date	End Date	Mean	Max.	Min.	OBS	S
N. Fork Licking River LE	75/07/10	75/12/16	1.3	2.0	1.0	4	0.5
Licking River McKinneysburg	65/01/02	65/09/30	0.0	0.0	0.0	9	0.0
	63/10/29	65/09/30	0.0	0.0	0.0	23	0.0
Licking River Butler	75/01/08	75/10/09	.75	2.0	0.0	4	.96
	74/10/17	74/10/17	1.0			1	
Licking River Catawba	75/01/25	75/06/25	2.0			1	
	74/03/14	74/12/10	1.5	4.0	0.0	6	1.5

Bacteriological Data — Total Coliform Kentucky Standard 1000/100 ml

STORET #31503 — Total Coliform Colonies per 100 ml
STORET #31616 — Fecal Coliform Colonies per 100 ml

Station	Beg. Date	End Date	Mean	Max.	Min.	OBS	S
Licking River Falmouth							
Total Coliform	75/01/06	75/12010	7575	62600	250	19	
Fecal Coliform	75/05/07	75/12/18	1296	3700	137	8	
Licking River Paris	75/01/21	75/12/23	470	1600	69	11	
Total Coliform	75/04/15	75/12/23	688	6800	29	22	
Licking River Cynthiana							
Total Coliform	75/01/06	75/12/18	3307	20800	50	18	
Fecal Coliform	75/03/24	75/12/18	1249	8100	4	9	
Licking River Kenton Co.							
Total Coliform	75/01/06	75/12/18	2240	14800	3	18	
Fecal Coliform	75/03/25	75/12/18	574	2100	84	8	



BIG SANDY RIVER

THE BIG SANDY RIVER BASIN

The Big Sandy River Basin is the eastern most river basin in Kentucky. This basin is part of the most mountainous section of Kentucky. The first section of this report will deal with the general description of the area, both physical and population. The second section will enter into an analysis of the water quality in the basin, its causes and effects.

I. A Description of the Big Sandy River Basin

A. Geography

The Big Sandy River Basin lies in the states of Kentucky, West Virginia and Virginia. That portion of the basin which lies in Kentucky is bordered on the east by the Kentucky-West Virginia border, to the south by the Kentucky-Virginia border, and on the west by the Kentucky, Licking and Little Sandy River Basins. The western border runs through eastern Letcher County, Knott County, eastern Magoffin County, northwestern Johnson County, northwestern Lawrence County and Boyd County.

The main stem of the Big Sandy River is formed by the junction of the Tug and Levisa Forks at Louisa, Kentucky and flows northerly 27 miles to enter the Ohio River about 10 miles downstream from Huntington, West Virginia. This river enters the Ohio River 664.3 miles from the Mississippi River. It drains 4,280 square miles of which 2,285 are drained in Kentucky. The Levisa Fork rises in southwest Virginia and flows north for 34 miles in Virginia and 130 miles in Kentucky to Louisa. The Tug Fork rises in southwestern West Virginia and flows northwest about 60 miles to Kentucky, whence it forms the boundary between Kentucky and West Virginia for about 94 miles. Principal tributaries of Levisa Fork are Russell Fork (127 sq. mi.), Beaver Creek (92 sq. mi.), and Johns Creek (74 sq. mi.). There are no significant tributaries to the Tug Fork in Kentucky.

B. Topography

The character of land in the Big Sandy River Basin varies from mountainous terrain in its upper portions to hilly areas along the Big Sandy River. Over most of the area, the streams and their tributaries flow in deep, narrow, sinous valleys between the steep-sided ridges. In the headwaters, the terrain includes the deepest gorge in the southeastern United States while in the lower portions of Boyd and Lawrence Counties the valleys are relatively wide with gently sloping hills. Physiographically, the Big Sandy River is wholly within the Appalachian Plateau.

The elevation of the Big Sandy River ranges from 2,400 feet above mean sea level (m.s.l.) (Levisa Fork) and 2,200 feet above m.s.l. (Tug Fork) at its headwaters to 498 feet above m.s.l. at its mouth on the Ohio River.

Slope, directly relates to the reaeration rate of a stream. With slopes from 0-2 ft./mi. the reaeration is low. Slopes from 3-6 ft./mi. give a medium reaeration while slopes of 7-10 ft./mi. give a high reaeration. The average slope of the Big Sandy River is 9.9 ft./mi. Slopes of the main stem, Levisa Fork below Russell Fork, and the lower 65 miles of Tug Fork average 1.3 to 2.3 ft./mi.

Many of the tributaries have a much greater average slope than the main stem. Russell Fork has an average slope of 24.9 ft./mi., Beaver Creek has an average slope of 34.3 ft./mi., Pigeon Creek has an average slope of 32.9 ft./mi., Big Creek has an average slope of 57.3 ft./mi., Peter Creek has an average slope of 63.0 ft./mi. Several other streams have average slopes of over 50 ft./mi.

C. Geology

The Big Sandy River Basin itself is not generally conducive for agricultural practices except for timber production. Generally, the soil is of limited depth, the land is steep and subject to erosion from runoff and wind. The principal geological feature of this area which directly and indirectly contributes to the water quality is the coal resource. The coal from this region is generally of metallurgical grade and suitable for production of coke. The coal has a low ash, low sulfur content and a high BTU value. The Big Sandy gas field is located in the area of the Tug and Levisa Forks. Scattered throughout the area are several small petroleum fields.

Because of the geology, the surface water of the Big Sandy River Basin is mainly sulfate-bicarbonate type with some chloride effects from oil fields in the extreme northern area around Blaine Creek and Louisa.

Aquifers are underground layers of porous rock from which ground-water is obtained. Two types of aquifers are found in the portion of the Big Sandy River Basin below the confluence of the Tug and Levisa Forks. On the eastern part of the basin, near the river, the aquifer yield is 500-1,000 gallons per minute (g.p.m.) while to the west the yield is 50 or less g.p.m. Above the confluence of the Tug and Levisa Forks, the ground water resource is characterized by the potential yield of the aquifers as follows: approximately 50 per cent of the area will produce 50 or less g.p.m., 48 per cent of the area will produce 50-500 g.p.m., and 2 per cent of the area will produce 400-1,000 g.p.m.

D. Hydrology

The stream flow of the Big Sandy Basin is shown from three gauging station records: the Big Sandy River at Louisa and the Levisa Fork at Prestonsburg and at Paintsville. The flow record summary includes drainage area, average flow, maximum and minimum flow and 7 day 10 year flow.

There are no active locks and dams on the main stem of the Big Sandy. In Kentucky the Corps has constructed two impoundments (Dewey and Fishtrap Lakes) on the Levisa Fork. The water surface totals 2,231 acres with a pool capacity of 103,000 acre feet. Both Dewey Lake and Fishtrap Lake are used for flood control, fish and wildlife, and recreation. Fishtrap Dam is also used for low flow augmentation (190 cubic feet per second).

E. Population

The population of the Big Sandy River Basin is basically rural in nature. Farms and towns are situated closely along the main stem and tributaries. The majority of population is located near the headwaters with 61,000 people residing in Pike County, 35,000 in Floyd County, and 17,000 in Johnson County. The main cities are Paintsville (Johnson) with a population of 7,300, Prestonsburg (Floyd) with 6,100, and Pikeville (Pike) with 4,900. The largest city near the mouth is Catlettsburg (Boyd County) with 3,400 people.

TABLE J-4

SURFACE WATER RECORDS FOR THE BIG SANDY RIVER BASIN

STATION	PERIOD OF RECORD	DRAINAGE AREA	AVERAGE FLOW	MAXIMUM FLOW	MINIMUM FLOW	7-day/10-yr. LOW FLOW
Levisa Fork at Prestonsburg **	12 yr.	1,701 sq.mi.	2,161 cfs, 1.3cfs*/sq.mi.	44,000 cfs, 26cfs/sq.mi.	20 cfs, 0.0cfs/sq.mi.	206 cfs
	wtr/yr 1975		3,201 cfs, 1.9cfs/sq.mi.	28,000 cfs, 16cfs/sq.mi.	197 cfs, 0.1cfs/sq.mi.	
Levisa Fork at Paintsville ***	48 yr.	2,143 sq.mi.	2,491 cfs, 1.2cfs/sq.mi.	69,700 cfs, 33cfs/sq.mi.	8.4 cfs, 0.0cfs/sq.mi.	210 cfs
	wtr/yr 1975		4,234 cfs, 2.0cfs/sq.mi.	31,700 cfs, 15cfs/sq.mi.	253 cfs, 0.1cfs/sq.mi.	
Big Sandy at Louisa ***	37 yr.	3,892 sq.mi.	4,452 cfs, 1.1cfs/sq.mi.	89,400 cfs, 23cfs/sq.mi.	Not determined	242 cfs
	wtr/yr 1975		7,354 cfs, 1.9cfs/sq.mi.	57,700 cfs, 15cfs/sq.mi.	479 cfs, 0.1cfs/sq.mi.	

* Cubic feet per second

** Flow regulated since October, 1968 by Fishtrap Lake, since August, 1966 by North Fork Pound River Lake, and since March, 1965 by John W. Flannagan Lake.

*** Flow regulated since October, 1968 by Fishtrap Lake, since August, 1966 by North Fork Pound River Lake, since March, 1965 by John W. Flannagan Lake, and since May, 1950 by Dewey Lake.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7-day/10-yr. low flow was taken from the waste load allocation produced as a component of the 303e River River Basin Continuing Planning Process.

II. Basin Water Quality

The basic recorded water quality of the basin is presented along with some of the major causes and effects. Also presented are the major users of surface water in the basin.

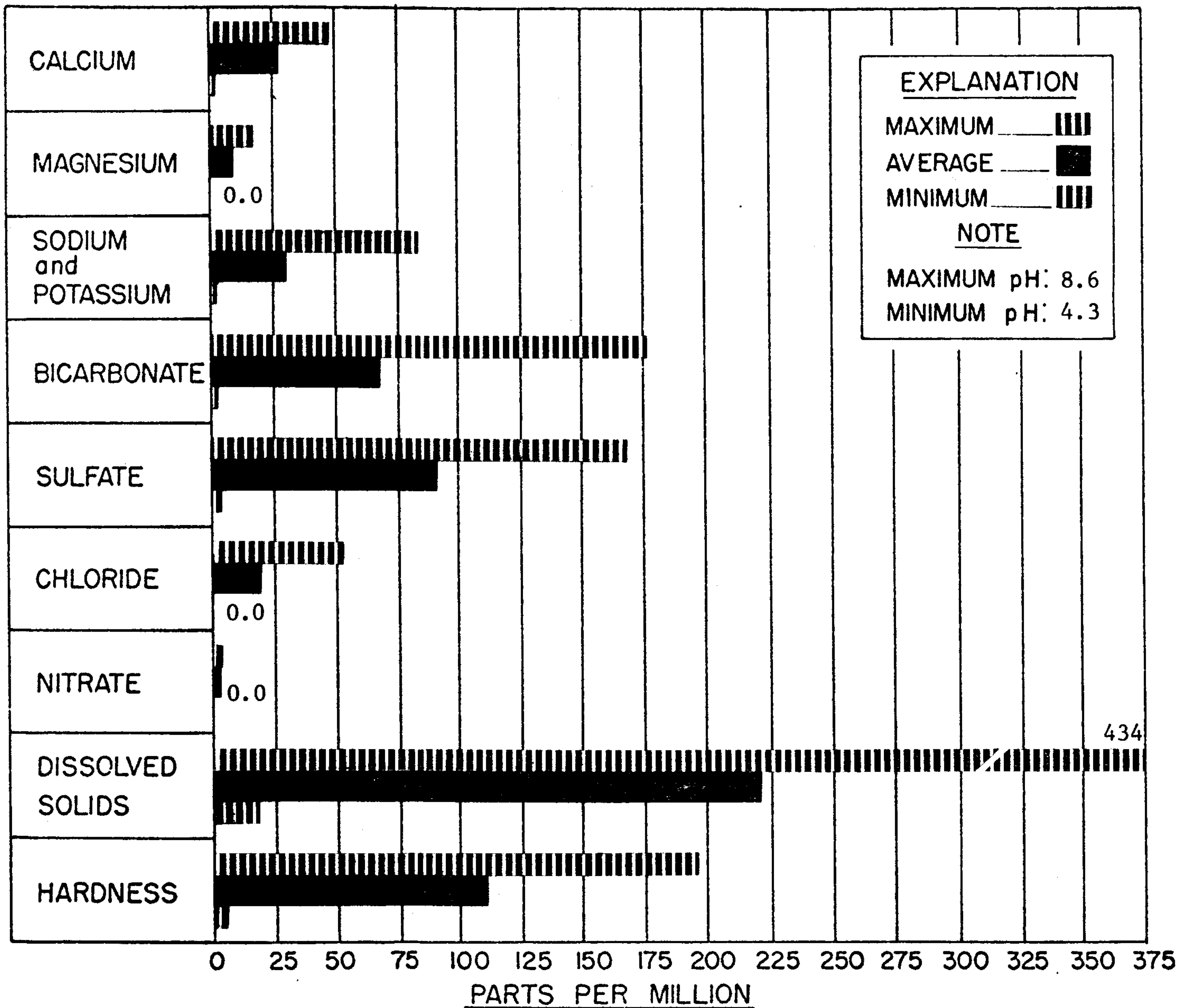
A. Description of Water Sampling Station

The U.S.G.S. station and Kentucky Water Quality Station, from which data in the following two sections was collected, are both located near Louisa, Kentucky in Lawrence County on the main stem of the Big Sandy River. The area of the basin above the stations is approximately 3,890 sq./mi., which is approximately 91% of the total basin area.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes the predominate chemical characteristics. This contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky are ones which have moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

FIGURE J-1

Big Sandy River

Louisa

5-65 to 6-74

is pronounced when either chloride or sodium exceeds 20-25 parts per million as an average value. The water quality data is summarized in Table J-8 and a graph is presented to show the general chemical water quality. In the Big Sandy River Basin, the water is moderately hard in general but has ranged from soft to very hard at times. The sulfate content is, on an average, 30 per cent higher than the bicarbonate level in the streams. The pH, on an average, is within Kentucky Water Quality Standards (6-9), however, it has dropped to a recorded low of 4.3. These relationships reflect in part the influence of mining operation throughout a large portion of the basin.

The average concentration of sodium and chlorides in the stream indicates higher than expected levels which may be attributed to the activity of oil production from the Blaine Creek Basin.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

The trace chemicals measured in the Big Sandy River Basin are within Kentucky-Federal Water Quality Standards.

D. Waste Load Effect on Water Quality

Biochemical degradable wastes impose a load on the dissolved oxygen resources of a stream. Such waste loads are considered to have an adverse effect on water quality when they cause the D.O. concentration of the water to drop below the Kentucky water quality standard of 5.0 mg/l.

Waste load allocations were made for approximately 560 miles of streams using a model developed for the Kentucky Continuing Planning Process for River Basin Management Planning. The results show that approximately 250 miles would have a D.O. concentration of less than 5.0 mg/l when the flow is equal or less than the once in ten year, seven day low flow. This is attributed to the fact that in the Big Sandy Basin, the tributaries have zero flow during most years. On the main stem, approximately ten miles are affected while on the tributaries 240 miles will be affected, based on present treatment levels.

Of the stream length affected, 5 miles (2%) are affected by industry (mostly coal related), 10 miles (4%) by municipalities, and 235 miles (98%) by other discharges such as schools, trailer parks, subdivisions, etc.

The quantities of waste loads causing this effect are 80,000 gallons from industries and 520,000 gallons from municipalities.

E. Non-point Pollution

Major sources of non-point pollution of the basin's streams are coal mining and solid waste. Soil erosion from surface mined lands and forestland which has been harvested are the leading sources, followed by agricultural lands, roadbanks, streambanks, and developing areas are the main sources of sediment. Solid waste problems are a result of the lack of adequate facilities for collection and disposal of solid waste.

Areas which contribute to soil erosion are summarized as follows:

1. Strip mining, a major cause of sedimentation, is difficult to quantitate as to the area or amount. The impact in a selected area indicated the mining effects of underground and surface mining.

2. An estimated 380 sq./mi. (12% of total basin) of forest land have excessive erosion as a result of logging operations and forest fires.

3. About 4.7 sq./mi. (.2% of total basin) of cropland are eroding at rates exceeding acceptable levels.

4. About 1.6 sq./mi. (.07% of total basin) of critical area and 3,000 miles of roadbank are eroding excessively.

Most of the surface water withdrawn for usage in the Big Sandy River Basin is used for public water supply. Approximately 3.9 million gallons per day (m.g.d.) (71% of total) is withdrawn for public supply with 1.6 m.g.d. (29%) being withdrawn for industrial usage.

According to the Kentucky Department of Fish and Wildlife, the Big Sandy River Basin also includes approximately 770 linear miles of stream which have been found capable of supporting a stream fishery. Five streams (120 miles) are considered to be of outstanding quality. Streams of lesser quality total 460 miles and 190 miles have been affected by pollution. The primary form of this pollution is siltation from non-point sources.

G. Water Quality Change

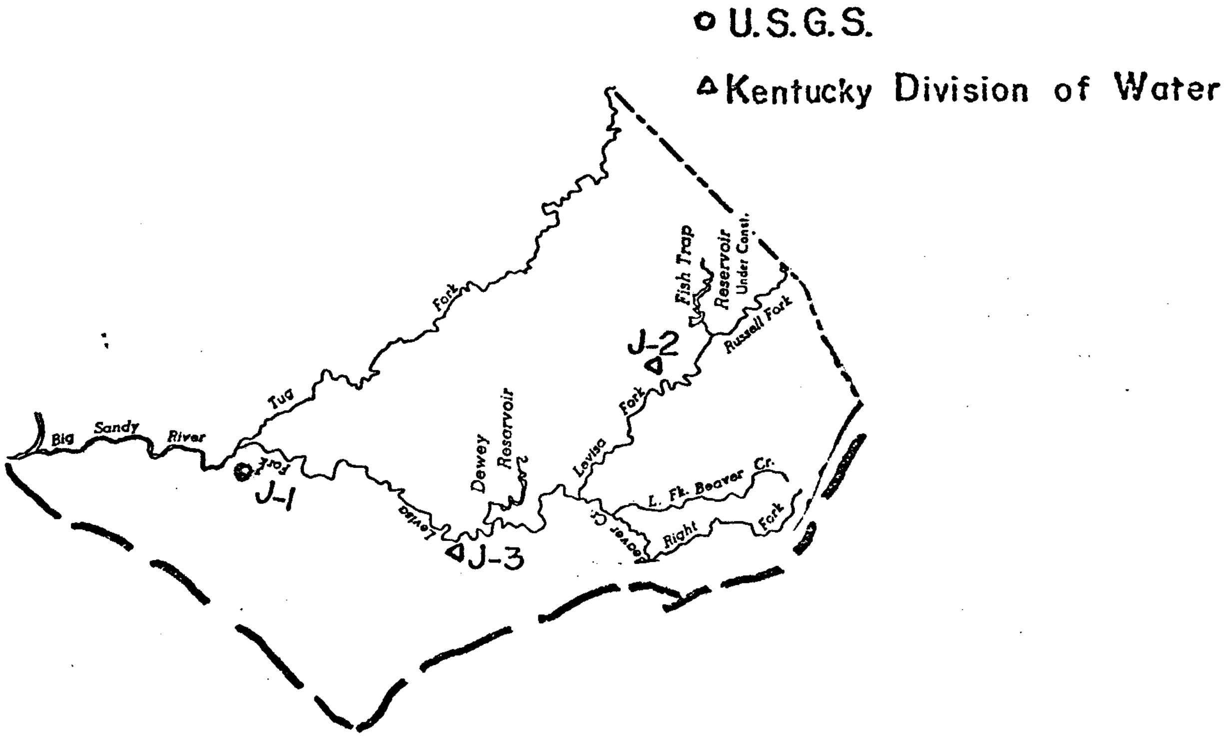
The demand for coal and the expected output from Kentucky at three times the current level or approximately 400 million tons per year foreshadows all other considerations of the Big Sandy River Basin. Even with a controlled program which can minimize the effects of sedimentation of surface mining and the effects of acid mine drainage from both surface or underground mining, water quality deterioration can be expected in the form of both siltation and a major modification of the general chemical water quality by adding to the total dissolved solids and changing the type of water from a bicarbonate to a sulfate type water.

III. Summary - Water Quality Causes and Corrections

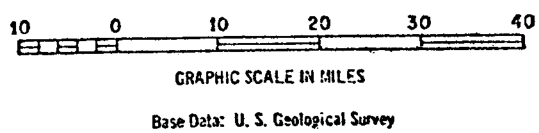
The two main problems in this basin in relation to water quality are from siltation and wasteloads.

Siltation is primarily from two aspects of the coal mine industry, logging and strip mining. Logging can result in high runoff rates and serious erosion while strip mining leads to sedimentation from upheaval of surface soil. With the increase in demand for coal due to the energy crisis, great care and vigilance will need to be exercised to see that this problem does not increase.

The problem organic discharges are from concerns such as schools, subdivisions, and trailer parks which are located on small tributaries where the low flow is often zero and the main part of the flow is often the effluent. This will be alleviated to a great extent by upgraded sewage treatment facilities.



BIG SANDY RIVER



STATION KEY

J-1 BIG SANDY RIVER AT LOUISA
J-2 LEVISA FORK AT PIKEVILLE
J-3 LEVISA FORK AT PAINTSVILLE

TABLE J-1
Length and Drainage Areas of Streams in the
Big Sandy Basin

STREAM	MILES ABOVE MOUTH OF BIG SANDY RIVER	DRAINAGE AREA (square miles)	LENGTH IN MILES TO HEADWATERS
Big Sandy River:			
Big Sandy River	0.0	4290.0	191.0
Blain Creek	19.6	265.0	51.3
Levisa Fork:			
Levisa Fork	26.8	2331.0	164.2
Paint Creek	65.4	168.7	34.0
Johns Creek	73.7	224.1	64.1
Middle Creek	81.8	65.0	17.1
Beaver Creek	91.8	240.2	46.0
Mud Creek	102.3	52.4	12.0
Shelby Creek	123.0	115.0	20.0
Russell Fork	127.2	678.5	44.9
Elkhorn Creek	138.9	53.4	20.5
Tug Fork:			
Tug Fork	26.8	1555.0	155.3
Rockcastle Creek	37.0	120.9	33.3
Wolf Creek	63.6	83.5	16.5
Big Creek	75.6	59.4	21.0
Pond Creek	84.7	40.7	13.5
Blackberry Creek	98.9	20.2	9.5
Peter Creek	104.5	34.5	13.5

TABLE J-2

County Areas in the
BIG SANDY BASIN

COUNTY	AREA IN SQUARE MILES (1)	PERCENT AREA IN BASIN (2)	AREA IN SQUARE MILES IN BASIN
Boyd	159	27	43
Floyd	401	100	400
Johnson	264	100	260
Knott	356	28	100
Lawrence	425	92	390
Letcher	339	6	23
Magoffin	303	4	12
Martin	231	100	230
Morgan	369	10	37
Pike	786	100	790
			2,285

1. Area - U. S. Census - Source of Measurement Unknown - Approximately ± 10%

2. Percent in Basin - Federal Water Pollution Control Administration - Ohio River Basin Framework Comprehensive Study

3. USGS - Area 2,284 Square Miles - From 7.5 Minute Quadrangle Topographical Map

TABLE J-3

SLOPE CHARACTERISTICS OF BIG SANDY RIVER AND ITS PRINCIPAL TRIBUTARIES

STREAM	Elevation at source (feet above m.s.l.)	Miles above mouth of Big Sandy River	Length of Stream (miles)	Average slope (ft./mi.)
Big Sandy River	2400	0.0	191.0	9.9
A. Levisa Fork	2400	26.8	164.2	11.3
a. Russell Fork	1770	127.2	44.9	24.9
1. Pound River	2250	148.2	44.8	24.1
a. Cranesnest River	1620	154.7	24.2	13.6
b. McClure River	1620	151.5	21.0	17.6
b. Beaver Creek	1800	91.8	46.0	34.3
c. Johns Creek	1800	73.7	64.1	19.0
d. Paint Creek	1035	38.6	34.0	12.9
B. Tug Fork	2200	26.8	154.2	10.9
a. Rockcastle Creek	1050	37.0	33.3	15.3
b. Pigeon Creek	1600	68.4	30.4	32.9
c. Big Creek	1800	75.6	21.0	57.3
d. Peter Creek	1550	104.5	13.5	63.0
e. Knox Creek	1500	111.8	20.0	38.4
f. Dry Fork	2250	135.7	40.7	31.4
1. Big Creek	1700	161.1	14.4	55.5
g. Elkhorn Creek	2300	159.5	22.6	45.2
h. Panther Creek	1700	128.7	14.4	55.5
C. Blaine Creek	900	19.6	51.3	7.6

1/ Includes Levisa and Tug Forks.

TABLE J-5

LAKES OF KENTUCKY IN BIG SANDY RIVER BASIN
OVER 100 ACRES OR 1000 ACRE-FEET

NAME	COUNTY	POOL CAPACITY (AF)	AREA (AC)
Dewey Lake	Floyd	76,100	1,100
Horseford Creek Dam	Lawrence	2,510	57
Jenkins Mine Refuse Dam (owned by Beth-Elkhorn Coal Company)	Letcher	2,600	30
Fishtrap Lake	Pike	27,190	1,130
McAndrews Refuse Dam (owned by Eastern Coal Company)	Pike	2,470	17

(AF) = Acre Feet
(AC) = Acres

Table J - 6

City Population and Facility Grant Status
in the Big Sandy River Basin in Kentucky

County	City	Population	Project Type	Comments
Boyd	Catlettsburg	3,420	I	Underway
Floyd	Prestonsburg	6,100	I	Underway
	Wheelwright-	1,781	I	Underway
	Allen	724		
	Wayland	384		
	Martin	786		
Johnson	Paintsville-Van Lear	7,300	I	Underway
Lawrence	Louisa	1,781	I	Underway
Martin	Inez	566	I	Underway
	Martin Co W. D. #2		I	Underway
Pike	Pikeville	4,900	I	Underway
	Phelps	770	None	No sewers

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this informantion was the 1970 U. S Census and the FY 75 construction grants list for Kentucky.

TABLE J-7

Population of the Big Sandy Basin

COUNTY	POPULATION IN 1970		POPULATION IN BASIN	
Boyd	52,376		8,700	
Floyd	35,889		35,889	
Johnson	17,539		17,539	
Knott	14,698		3,900	
Lawrence	10,726		9,950	
Letcher	23,165		3,800	
Magoffin	10,443		380	
Martin	9,377		9,377	
Morgan	10,019		870	
Pike	61,059		61,059	
		TOTAL	151,000	(approximate)

Table J - 8

Water Quality Data For Big Sandy River Basin

Station	Beg. Date	End Date	Mean	Max.	Min.	#OBS.	S
STORET #00400	pH Specific Units, Ky. std. 6 LT pH LT 9						
Big Sandy R - Louisa	75/01/16	75/12/11	7.3	8.1	6.7	11	.481
USGS 03215000	70/04/22	74/12/18	7.4	7.9	6.7	13	.368
	65/05/22	74/12/18	7.3	8.0	6.7	31	.353
STORET #00095	Conductivity Micro mhos Ky. std. 800 Micro mhos						
Big Sandy R - Louisa	75/01/16	75/12/11	360.5	550.0	205.0	11	127.6
USGS 03215000	70/03/11	74/12/18	360.0	580.0	150.0	27	137.1
	65/05/22	74/12/18	396.5	729.0	150.0	55	154.2
STORET #70300	Dissolved Solids mg/l Ky. std. 500 mg/l						
Big Sandy R - Louisa	75/01/16	75/10/15	216.4	338.0	118.0	9	83.8
USGS 03215000	70/04/22	74/12/18	212.5	346.0	99.0	13	80.0
	65/11/14	74/12/18	239.9	447.0	97.0	30	114.3
STORET #00410	Alkalinity mg/l No Standard						
Big Sandy R - Louisa	75/01/16	75/10/15	65.7	115.0	25.0	9	35.0
USGS 03215000	70/04/22	74/12/18	55.7	110.0	20.0	13	26.6
	65/05/22	74/12/18	58.5	123.0	20.0	25	31.6
STORET #00900	Hardness mg/l 0-60 soft, 60-120 mod.hard, 121-180 hard over 180 very hard						
Big Sandy R - Louisa	75/01/16	75/10/15	119.6	170.0	82.0	9	36.6
USGS 03215000	70/04/22	74/12/18	109.8	170.0	57.0	13	36.2
	65/05/22	74/12/18	117.5	196.0	50.0	31	41.0
STORET #00930	Sodium mg/l No Standard						
Big Sandy R - Louisa	75/01/16	75/10/15	26.5	48.0	7.6	9	16.2
USGS 03215000	70/10/14	74/12/18	30.0	54.0	12.0	5	18.9
	66/07/13	74/12/18	41.4	75.0	12.0	9	21.6
STORET # 00935	Potassium mg/l No Standard						
Big Sandy R - Louisa	75/01/16	75/10/15	2.8	3.8	1.8	9	.923
USGS 03215000	70.10/14	74/12/18	3.4	4.8	2.0	5	1.1
	66/07/13	74/12/18	3.7	5.1	2.0	9	1.0
STORET # 00940	Chloride mg/l Prop. E. P. A. Std. 250 mg/l						
Big Sandy R - Louisa	75/01/16	75/10/15	10.7	26.0	3.4	9	7.8
USGS 03215000	70/04/22	74/12/18	14.2	28.0	3.7	13	9.1
	65/05/22	74/12/18	19.2	52.0	3.7	31	14.3

Table J-8
Continued

STORET # 00618	Nitrate - N mg/l Prop. E. P. A. Std. 10 mg/l						
Big Sandy R - Louisa	72/01/06	72/07/24	.48	.73	.20	3	.266
USGS 03215000	66/10/11	72/07/24	.46	.73	.20	4	.219
STORET #00950	Flouride mg/l Ky. Std. 1.0 mg/l						
Big Sandy R - Louisa	75/01/16	75/10/15	.14	.40	0.0	9	.142
USGS 03215000	70/09/09	74/12/18	.13	.20	0.0	8	.071
	65/11/14	74/12/18	.11	.2	0.0	15	.074
STORET #00915	Calcium mg/l No Standard						
Big Sandy R - Louisa	75/01/16	75/10/15	28.9	41.0	19.0	9	9.5
USGS 03215000	70/10/14	74/12/18	29.8	43.0	19.0	5	11.3
	66/07/13	74/12/18	32.6	48.0	19.0	9	11.3
STORET #00945	Sulfate mg/l Prop. E. P. A. Std. 250 mg/l						
Big Sandy R - Louisa	75/01/16	75/10/15	92.4	130.0	64.0	9	26.9
USGS 03215000	70/04/22	74/12/18	100.7	169.0	37.0	31	36.6
	65/05/22	74/12/18	100.7	169.0	37.0	31	36.6
STORET #00925	Magnesium mg/l No Standard						
Big Sandy R - Louisa	75/01/16	75/10/15	11.5	17.0	7.6	9	3.2
USGS 03215000	70/10/14	74/12/18	12.7	17.0	8.3	5	3.9
	66/07/13	74/12/10	13.3	17.0	8.3	9	3.4
STORET #00080	Color Platinum - Colbart Units Prop. EPA Std. 75 Units						
Big Sandy R - Louisa	70/10/14	70/10/14	5.0	5.0	5.0	1	--
USGS 03215000	65/05/22	70/10/14	5.7	10.0	4.0	6	2.1
STORET # 01025	Cadmium Micrograms/Liter Ky. Std. 100 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	1.0	2.0	0.0	4	.816
USGS 03215000	74/04/07	74/10/23	1.2	3.0	0.0	5	1.0
STORET #01056	Manganese ug/l Prop. Ky. Std. 50 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	13.3	30.0	0.0	3	15.2
USGS 03215000	74/10/23	74/10/23	17.0	17.0	17.0	1	--
STORET # 01046	Iron ug/l Prop. E. P. A. Std. 300 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	550.0	1600.0	9.9	3	909.4
USGS 03215000	74/10/23	74/10/23	0.0	0.0	0.0	1	--
STORET # 01030	Chromium ug/l Ky. Std. 50 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	.75	2.0	0.0	4	.957
USGS 03215000	74/04/07	74/10/23	.8	3.0	0.0	5	1.3

Continued

STORET #01049	Lead ug/l Ky. Std. 50 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	3.25	10.0	0.0	4	4.7
USGS 03215000	74/04/07	74/10/23	8.6	17.0	2.0	5	7.3
STORET #01000	Arsenic ug/l Ky. Std. 50 ug/l						
Big Sandy R - Louisa	75/01/16	75/07/09	.25	1.0	0.0	4	.5
USGS 03215000	74/04/07	74/10/23	3.0	9.0	0.0	5	3.7
Bacterialogical Data							
STORET #31503	Total Coliform Colonies per 100 ml Ky. Std. 1000/100ml						
STORET #31616	Fecal Coliform Colonies per 100 nl						
Levisa Fork Pikeville							
T Coliform	75/02/19	75/10/30	13681	65000		10	7
F Coliform	75/20/19	75/07/30	5256	2400		0	5
Levisa Fork, Paintsville							
T Coliform	75/02/19	75/10/30	7387	15000		8	8
	75/02/19	75/10/30	7387	1220		8	8
F Coliform	72/02/19	75/07/30	830	1220		450	5
	72/02/19	75/07/30	830	1220		450	5

Water Withdrawal - Big Sandy Basin

	WATER USAGE	SW *	GW **	(Million Gallons/Day) PUBLIC	INDUSTRIAL
BOYD					
Catlettsburg, Kenova, Ceredo Water Co., Inc.	Big Sandy	x		1.081	.033
Calgon Corporation	Big Sandy	x	x		.007 GW .432 SW
FLOYD					
Allen Mun. Water Comm.	Beaver Creek	x		.048	.005
Francis Water Company	R. Fk. Beaver Creek	x		.033	
Kentucky Hydrocarbon	R. Fk. Beaver Creek	x			.186
Martin Municipal W. W.	Beaver Creek	x		.102	
Prestonburg Municipal Water Works	Levisa Fork	x		.356	
Beaver Elkhorn Water District		x	x	.150 GW Mar-May .159 SW June-Feb	
Island Creek Coal Co.	Beaver Creek	x			.257
JOHNSON					
Paintsville Municipal Water Works	Levisa Fork	x		.404	.101
Van Lear, Kentucky Water Company	Levisa Fork	x		.142	.003
LAWRENCE					
Louisa Municipal Water Works	Levisa Fork	x		.296	.197
LETCHER					
Jenkins, Kentucky Water Company	Elkhorn Lake	x		.578	.064
PIKE					
Feds Creek Coal Co.	Big Creek	x	x		.050 SW .005 GW
Kentland-Elkhorn Coal Company	Big Creek	x	x		.221 GW & SW
Elkhorn City Municipal Water Works	Russell Fk.	x		.066	
Pikeville Coal Company		x	x	.001 GW	.085 SW

Continued - J-9

Pikeville Municipal Water Works	Big Sandy	x	.641	.033
Shelbiana (C & O Railroad)	Levisa Fk.	x	.031	.058

* SW = surface water
** GW = ground water

Contents of Lakes Report

Lakes Summary

This section represents that portion of the Water Quality Strategy in Kentucky which addresses lake water quality. It is intended as an extension of the Inventory of Lakes section in the Division of Water Quality 1974 Program Plan which is presented on the following page. The U.S. Army Corps of Engineers, as a participant in the coordinated water quality monitoring effort in Kentucky, has submitted water quality summaries for their fourteen major projects in the state. Table 1 presents a brief outline of the contents of these summaries. In addition, Table 2 presents a summary of water quality conditions at the fifteenth federal impoundment, Kentucky Lake, and a major private impoundment, Herrington Lake. The Kentucky Lake and Herrington Lake summaries were developed on the basis of limited water quality data obtained from the Tennessee Valley Authority and the Kentucky Department of Fish and Wildlife, respectively. On the basis of total area, the sixteen lakes summarized in this section represent 95 percent of the lake surface area in the state of Kentucky. Following the presentation of the Corps of Engineers lake reports is a glossary of general terms used within this section.

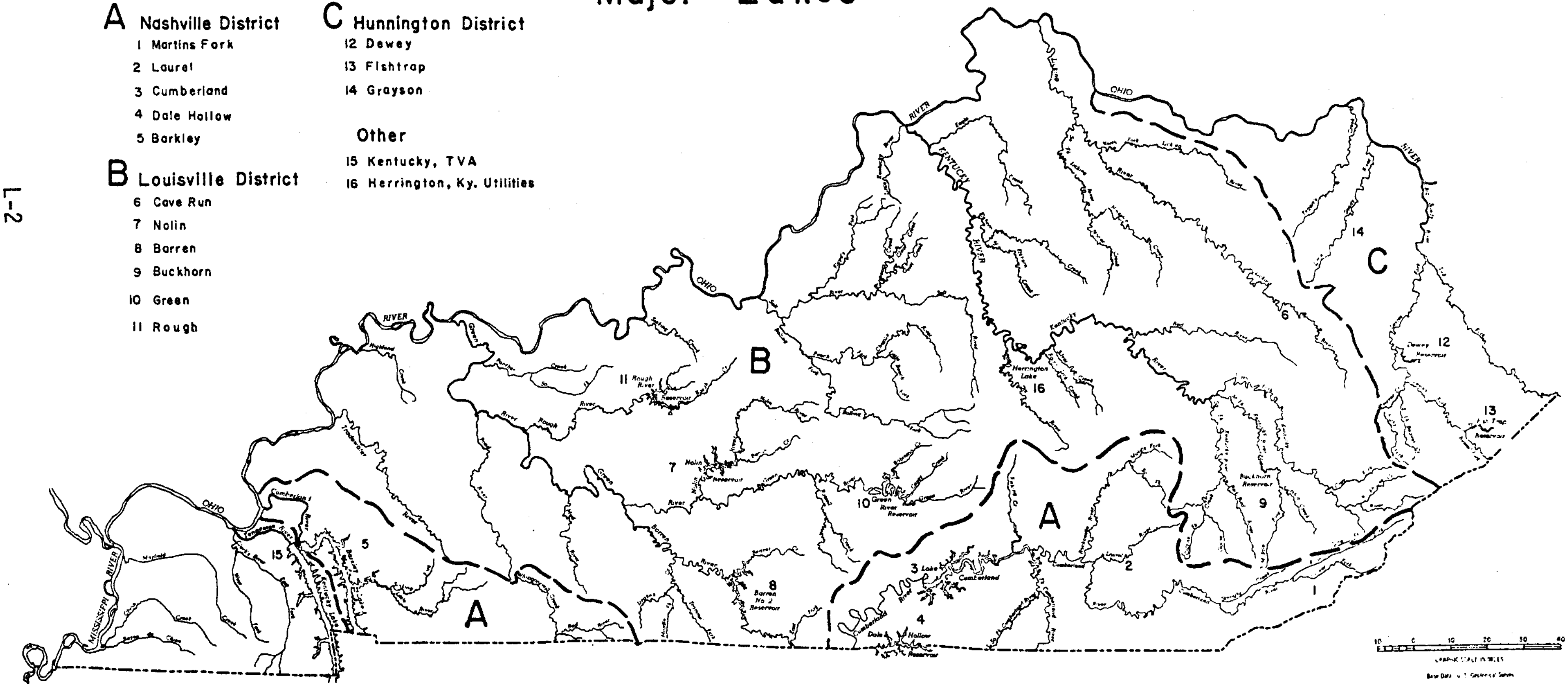
Major Lakes

A Nashville District
1 Martins Fork
2 Laurel
3 Cumberland
4 Dale Hollow
5 Barkley

B Louisville District
6 Cave Run
7 Nolin
8 Barren
9 Buckhorn
10 Green
11 Rough

C Hunnington District
12 Dewey
13 Fishtrap
14 Grayson

Other
15 Kentucky, TVA
16 Herrington, Ky. Utilities



INVENTORY OF LAKES

	Federal USCE	S.C.S. State Municipal	Private
Total number of publicity owned fresh water lakes in the state	15	153	122
Total number of significant lakes			
Number of significant lakes exhibiting noticeable eutrophy			
Number of significant lakes exhibiting no noticeable eutrophy			
Number of significant lakes for which eutrophication status is not known E. G., data is not readily available to make a determination of its eutrophic status.			
Total area of publicly owned fresh water lakes	313,961	10,109	5,830
Total area of significant lakes			
Area of significant lakes exhibiting noticeable eutrophy			
Area of significant lakes exhibiting no noticeable eutrophy			
Area of significant lakes for which eutrophication status is not known.			

1. Federal-4 of 15 were a part of the National Eutrophication Survey none of the lake exhibited noticeable eutrophy.

2. Soil Conservation Service, State & Municipal — Most are used for public water supply, are small to moderate in size (20 to 850 acre) and the cities treat the lakes for algae control which precludes a judgment on the Eutrophic status.

3. Private (excludes Herrington Lake 2940 acres owned by Kentucky Utilities). Many lakes are for fee fishing, a few for water supply. Some lakes have public access and are developed with summer cottages. The fishing lakes would tend to a mesoeutrophic or eutrophic status because of artificial fertilization.

TABLE L-1a

WATER QUALITY SUMMARY OF THE MAJOR U. S. ARMY CORPS OF ENGINEERS PROJECTS IN KENTUCKY

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
MARTINS FORK LAKE	NASHVILLE	Under Construction	Evaluation of water temperature data collected by U.S.G.S. will define the natural seasonal temperature regime.	Data base to be established after project completion.	Preimpoundment water quality data shows an increase in turbity levels and metals concentrations in Martins Fork.
LAUREL LAKE	NASHVILLE	1974	Typical of tributary type impoundment in the region.	Low hypolimnion dissolved oxygen, probably due to decay of organics in the recently impounded project. Trends in Hypolimnion dissolved oxygen to be monitored.	None Listed
LAKE CUMBERLAND	NASHVILLE	1950	Typical of tributary type impoundment in the region, however, all layers may not undergo complete mixing during winter.	Relatively low hypolimnion dissolved oxygen though not as severe as in similar projects.	Excessive turbidity in lower regions of lake.
DALE HOLLOW LAKE	NASHVILLE	1943	Typical of tributary type impoundment in the region.	Hypolimnion dissolved oxygen approaches zero near lake bottom in the fall.	None Listed
LAKE BARKLEY	NASHVILLE	1964	Does not stratify due to high current velocities in the upper reaches and low storage volume versus flow relationship.	Due to thermal stratification pattern, no significant dissolved oxygen problems exist, though isolated oxygen sags have been reported.	None Listed

TABLE L-1a
Continued

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
CAVE RUN LAKE	LOUISVILLE	1973	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
NOLIN RIVER LAKE	LOUISVILLE	1963	Typical of tributary type of impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Moderated dissolved phosphorus concentration.
BARREN RIVER LAKE	LOUISVILLE	1964	Typical of tributary type of impoundment in the region.	Dissolved oxygen stratification develops with thermal stratification. Low hopolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
BUCKHORN LAKE	LOUISVILLE	1960	Typical of tributary type of impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hopolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
GREEN RIVER LAKE	LOUISVILLE	1969	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.

TABLE L-1a
Continued

PROJECT	CORPS DISTRICT	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
ROUGH RIVER LAKE	LOUISVILLE	1959	Typical of tributary type impoundment in the region, having greatest impact on water quality in this lake.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolved oxygen near lake bottom.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Low dissolved phosphorus concentration.
DEWEY LAKE	HUNTINGTON	1950	Weak stratification during the summer.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Excessive levels of turbidity. High levels of iron and manganese correlating with high inflow levels. Occasional high mercury concentrations.
FISHTRAP LAKE	HUNTINGTON	1968	Weak stratification during the summer.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Excessive levels of turbidity. High levels of iron and manganese correlating with high inflow levels. Occasional high mercury levels in inflow and outflow.
GRAYSON LAKE	HUNTINGTON	1968	Typical of tributary type impoundment in the region.	Dissolved oxygen stratification develops with thermal stratification. Low hypolimnion dissolve oxygen near lake bottom. Outflow dissolved oxygen high due to high-level releases and stilling basin reaeration.	Excessive dissolved iron and manganese concentrations produced in oxygen depleted hypolimnion. Occasional high mercury levels. NOTE: Biological Survey Attached.

TABLE L-1b

WATER QUALITY SUMMARY OF THE MAJOR U. S. ARMY CORPS OF ENGINEERS PROJECTS IN KENTUCKY

PROJECT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
MARTINS FORK LAKE	Coal Mining Project related relocation work.	Possible water quality degradation due to mining activities or project relocation work.	Future efforts include expanded sampling, installation of automatic monitoring system, and preparation of project operation manual.
LAUREL LAKE	Project power generation in Fall of 1976. Future tailwater trout fishery.	Tailwater trout stocking program may have to be delayed until a means is found to alleviate poor quality releases from oxygen depleted hypolimnion.	Future efforts include expanded sampling and studies to find a means to alleviate the problem of poor water quality releases.
LAKE CUMBERLAND	Project power releases Tailwater trout fishery	Release of turbid water in lower regions of the lake causes water in the tailwater and downstream points to appear murky.	Future efforts include a complete evaluation of all available water quality data, a better definition of inflow quality, a definition of withdrawal zone produced by power releases, and a study of reaeration by turbulence in the tailrace.
DALE HOLLOW LAKE	Coal Mining Project power releases Tailwater trout fishery	Low dissolved oxygen hypolimnetic releases create concern for tailwater trout fishery. Water quality degredation due to mining activities in the watershed particularly in the East Fork, Obey River drainage.	Future efforts include a complete evaluation of all available water quality data, a better definition of inflow quality, a definition of the withdrawal zone produced by power releases, and a study of reaeration by turbulence in the tailrace.
LAKE BARKLEY	Project power releases	No significant adverse impacts with the exception of isolated oxygen sags.	Future efforts include a study of the monitoring deficiencies and adjustment of strategy for monitoring.

water quality control. Periodic sampling trips will be made to monitor those activities in the watershed which will effect the water quality of the project and to expand the data base where necessary. One area of special concern with very little data is Cranks Creek, a small impoundment on a tributary to Martins Fork.

TABLE L-1b
Continued

PROJECT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
GREEN RIVER LAKE	Liberty Sewage Treatment Plant Tailwater Trout Fishery	Negligible effect from Liberty Sewage Treatment Plant.	Influent water quality rated as excellent, having been only slightly altered from natural conditions.
ROUGH RIVER LAKE	Agriculture Tailwater Trout Fishery Leitchfield Municipal Water intake.	No nuisance algae blooms caused by nutrients produced by agricultural activity. Problem at Leitchfield Water Plant alleviated by switching from deepest intake to shallowest intake during stratification.	Influent water quality rated as relatively good.
DEWEY LAKE	Coal Mining	Degradation of water quality due to coal mining, resulting in excessive sedimentation and metals concentrations with possibility of adverse effects on the pH regime in the near future. Severe hydrogen sulfide odors in stilling basin produced in the oxygen depleted hypolimnion.	Lake water quality rated as poor to degraded. Future efforts include intensified monitoring of the effects of coal mining, and monitoring of mercury concentration.
FISHTRAP LAKE	Coal Mining Tailwater Trout Fishery	Degradation of water quality due to coal mining, resulting in excessive sedimentation and metals concentrations with possibility of adverse effects on the pH regime in the near future.	Lake water quality rated as degraded to severely degraded Future efforts include intensified monitoring of the effects of coal mining.
GRAYSON LAKE	Coal Mining Tailwater Trout Fishery	No significant adverse impact on water quality by mining activities at this time.	Lake water quality rated as fair to good. Future efforts include monitoring programs focused at both inflow and lake stations, and cooperative studies and regulatory effort with the State of Kentucky and other appropriate agencies.

TABLE L-2a

WATER QUALITY OF OTHER MAJOR LAKES IN KENTUCKY

IMPOUNDMENT	GOVERNING AGENCY	YEAR IMPOUNDED	THERMAL STRATIFICATION	DISSOLVED OXYGEN SUMMARY	MISCELLANEOUS PARAMETER SUMMARY
KENTUCKY LAKE	TENNESSEE VALLEY AUTHORITY	1944	Pattern similar to Barkley Lake. Some period of weak stratification.	Due to thermal stratification pattern, no significant dissloved oxygen problems exist	No excessive concentrations of trace elements with the exception of ocasional high levels of manganese.
HERRINGTON LAKE	KENTUCKY UTILITIES	1925	Typical of tributary type impoundment in the region.	Density layering effects cause the creation of secondary oxygen maxima in the dissolved oxygen distribution. Low hypolimnion dissolved oxygen at various levels.	Ranges of pH and alkalinity indicative of high buffering capacity of watershed. Occasional hydrogen sulfide odors occurring in low dissolved oxygen level of primary oxycline.

TABLE L-2b

WATER QUALITY OF OTHER MAJOR LAKES IN KENTUCKY

IMPOUNDMENT	WATERSHED ACTIVITY	IMPACT OF WATERSHED ACTIVITY	PROJECT STATUS AND PLANS
KENTUCKY LAKE	Project Power generation Phosphate mining on Duck River.	No significant adverse impacts on water quality by phosphate mining on Duck River or other activities in upper reaches.	Lake water quality rated as excellent. Future efforts include continued monitoring by Tennessee Valley Authority and related agencies.
HERRINGTON LAKE	Project Power Generation.	No significant adverse impacts on water quality at this time.	Future efforts include expanded monitoring in order to broaden the data base.

GLOSSARY

USGS, GS - United States Geological Survey

S.T.P. - Sewage Treatment Plant

Dissolved Oxygen (D.O.) - The oxygen dissolved in sewage, water, or other liquid, usually expressed in milligrams per liter (mg/l).

Oxygen Sag - A curve that represents the profile of dissolved oxygen content along the course of a stream, resulting from the deoxygenation associated with biochemical oxidation of organic matter, and reoxygenation through the absorption of atmospheric oxygen and through biological photosynthesis.

Oxycline - The region in a dissolved oxygen profile of rapid increase or decrease of dissolved oxygen concentration.

Oxygen Demand - The quantity of oxygen utilized in the oxidation of organic matter.

Thermal Stratification - A physical characteristic of lakes and reservoirs in which the temperature profile is characterized by three distinct layers called, from top to bottom: the epilimnion, the thermocline, and the hypolimnion.

Epilimnion - The upper region in a lake profile of more or less uniformly warm, circulating, and fairly turbulent water.

Hypolimnion - The lower region in a lake profile of cold and relatively undisturbed water.

Thermocline - The region in a lake profile of rapid decrease in temperature separating the epilimnion from the hypolimnion.

Isothermal Condition - A condition indicating a uniform distribution of temperature throughout a lake profile.

Fall Mixing, Fall Turnover - A seasonal phenomenon occurring in most lakes in which the cooling of surface water and inflow water decreases the resistance to mixing and thus allows the epilimnion and thermocline to mix. The effect of increased cooling and increased mixing proceeds until wind action can successfully mix the lake to its full depth.

Summer Drawdown - The process of intermittent impoundment releases for the purpose of maintaining a seasonal pool elevation.

Glossary
Continued

Selective Withdrawal - The capability of withdrawing water of varing quality from various depths in a lake, utilizing a multilevel outlet structure.

Withdrawal Zone - That portion of a lake or reservoir located at the outlet structure and characterized by a particular water quality profile.

Trailwater - The portion of flow located just on the downstream side of a hydraulic structure.

Trailrace - A hydraulic structure for carrying the discharge from a dam to the stream channel.

Embayment - A formation resembling a bay.

Lake Morphometry - The form and structure of an impoundment.

Limnology - The science that deals with the physical, chemical, and biological properties and features of fresh waters.

Euphotic Zone - The depth through which the net effect of photosysthesis is positive.

Secchi Disc - A simple apparatus for determining the transparency of water.

Secchi Disc Depth - The depth at which a white secchi disc let down from the surface of the water just disappears from view.

Benthos - All the plants and animals living on or closely associated with the bottom of a body of water.

Non-Calcareous - The absence of calcium carbonate, calcium, or lime.

Trace Elements - Generally, these materials are heavy metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life.

Buffering Capacity - The capacity of a body of water to receive small amounts of acids and bases and not appreciably affect pH.

Glossary
Continued

<u>Turbidity</u> - A measure of fine suspended matter (usually colloidal) in liquids.

<u>Kjeldahl Nitrogen</u> - The total of the organic and ammonia nitrogen.

Water Quality Summary

Martins Fork Lake

The Nashville District has visited the Martins Fork project area on six occasions to collect preimpoundment water quality data. These data and data collected by other agencies have been evaluated and included in the project's General Désign Memorandum (GDM). Some additional data have been collected for the District by the U. S. Geological Survey (USGS). Samples are collected by the G. S. at six week intervals and mailed to the District and Division water quality laboratories for physical and chemical analyses. The USGS also maintains a water quality monitor near the dam site, which is capable of recording hourly temperature and specific conductance values.

In addition to evaluating area water quality conditions for the GDM, the District has also performed a withdrawal zone study to design selective withdrawals ports for the dam. This report was included in the project's Feature Design Memorandum. An automatic water quality monitoring system, which will provide data on conditions in the lake and tailwater when the project is completed, has also been designed.

Recent data collected from the project area show an increase in turbidity levels and metals concentrations in Martins Fork. Whether the problem is caused by mining activities or project related relocation work is not known.

The District's future water quality efforts will include an evaluation of the water temperature data collected by the USGS to define the natural seasonal temperature regime in Martins Fork. A project operation manual will be prepared to establish operating criteria for water quality control. Periodic sampling trips will be made to monitor those activities in the watershed which will effect the water quality of the project and to expand the data base where necessary. One area of special concern with very little data is Cranks Creek, a small impoundment on a tributary to Martins Fork.

Water Quality Summary

Laurel Lake

The Nashville District has collected water samples from Laurel Lake on only one occasion. The lake was impounded in June 1974 and sampled in August 1974. The sampling trip was made to gather information on the lake and its tributaries for the project's Environmental Impact Statement. Some additional data have been obtained from one of the tributaries through the cooperation of the U.S. Geological Survey (G.S.). The samples are collected by the G.S. at six week intervals and are mailed to the District and Division water quality laboratories for chemical and physical analyses. The District has established six sampling stations in the lake, one in the tailwater and one on a tributary.

An analysis of the data collected to date shows the lake, as expected, is subject to the thermal stratification pattern typical of other tributary type impoundments in the region. The major water quality problem discovered in the August 1974 sampling run is low hypolimnion dissolved oxygen (D.O.) concentrations. Much of the oxygen demand in the hypolimnion is undoubtedly due to the vegetation and other organic materials left in the areas flooded by the lake. At present all releases from the project are from the epilimnion via the uncontrolled spillway. The project's power unit is scheduled to go on line in the fall of 1976. Since power generation will result in the release of water from the hypolimnion, there is concern over the quality of such releases.

To determine any trends in hypolimnion D.O. concentrations, the District Water Quality Unit will attempt to make at least one visit to the project in CY 1976. Sampling efforts will be intensified in CY 1977 and 1978 to establish baseline water quality data for the project. If the D.O. in the hypolimnion remains low, studies will be undertaken to find means to alleviate the problem of poor quality releases. The District will also notify the Kentucky Game and Fish Commission of the problem in case they wish to delay their tailwater trout stocking program until water quality conditions in the tailwater are improved.

Water Quality Summary

Lake Cumberland

The Nashville District has collected a reasonably good data base for physical and chemical parameter from the lower two thirds of Lake Cumberland. No data have been collected from the upper third of the lake and only a very small amount of inflow data has been obtained. The District first collected water samples from the lake in April 1971 and has sampled the project an additional fifteen times since then. Some temperature profile data have been obtained by personnel assigned to the project. Additional sources of data include state agencies in Kentucky and the U.S. Geological Survey. The District has established six sampling stations in the lake, one in the tailwater and one on a tributary.

An analysis of availbale data indicates Lake Cumberland is subject to the thermal stratification and low hypolimnion dissolved oxygen (D.O.) concentrations typical of tributary type impoundments. Although there is depletion of the hypolimnion D.O., it does not appear as severe as the depletion observed at similar District projects. Surprisingly, the lowest D.O. concentrations observed at station 3WOL20002 (one half mile upstream of the dam) were observed in April 1971 at the beginning, not the end, of stratification. From this as well as data collected in 1972 it appears the lake may not undergo complete mixing of all layers during the winter.

Another water quality problem of concern is the turbidity in the lower regions of the lake. The release of this turbid water causes the water in the tailwater and at downstream points to appear murky. The available inflow data are insufficient to determine the sources of the problem.

During FY 1976 the District awarded a contract to Tennessee Technological University to compile and evaluate all available water quality data related to Lake Cumberland. The report of this study will be used to develop a Technical Studies Work Plan (TSWP) for future water quality investigations. The District's future sampling efforts, commensurate with the TSWP, will attempt to fill in gaps in the data base for the lake and obtain a better definition of the quality of inflows into the lake. In future studies the District will define the withdrawal zone produced by project power releases and study the reaeration created by turbulence in the tailrace immediately below the powerhouse.

Water Quality Summary

Dale Hollow Lake

The Nashville District's sampling program has established a reasonably good data base for physical and chemical parameters in Dale Hollow Lake. A small amount of data has also been collected from the major tributaries. No biological data have been obtained from either the lake or the tributaries. The District first collected water samples from the lake in April 1971 and has visited the project an additional thirteen times since then. In addition a good base of temperature profile data has been obtained by project personnel. Other sources of data include Tennessee Technological University, the Fish and Wildlife Service, the Environmental Protection Agency and state agencies in both Tennessee and Kentucky. The District has established nine sampling stations in the lake, one in the tailwater and six on tributaries to the lake.

The thermal stratification pattern in Dale Hollow is typical of other tributary type impoundments in the region. Dissolved oxygen (D.O.) profiles collected at station 3DAL20002 (about one half mile above the dam) show that D.O. concentrations in the hypolimnion approach zero in the deepest portions of the lake in the fall. This problem is of particular concern at Dale Hollow because of the tailwater trout fishery. One sample collected by the Water Quality Unit at station 3DAL10001 showed the tailwater D.O. concentration was less than 3 mg/l.

Another water quality problem of concern is the degradation of inflows due to mining activities in the watershed. The problem appears to be most severe in the East Fork, Obey River drainage. However, samples collected from the East Fork embayment show only a minor influence from mining activities on the quality of water in the embayment. The District Water Quality Unit has investigated two fish kills in the embayment and found both were due to a sudden change in water temperature caused by thunderstorm activity.

During FY 1976 the District awarded a contract to Tennessee Technological University to compile and evaluate all available water quality data related to Dale Hollow. The report generated by this study will be used to develop a Technical Studies Work Plan for future water quality investigations. The District's future sampling efforts will be aimed at filling in gaps in the water quality data base for the lake and in obtaining a better definition of the quality of inflows into the lake. In future studies the District will define the withdrawal zone produced by project power releases and study the reaeration caused by turbulence in the tailrace immediately below the powerhouse.

Water Quality Summary

Lake Barkley

The Nashville District has collected very little water quality data from Lake Barkley. The Water Quality Unit has collected samples from the lake on only two occasions since the project was first visited in October 1971. Additional sources of water quality data include the U. S. Geological Survey (tailwater, the Tennessee Valley Authority (data from the vicinity of Cumberland Steam Plant) and state agencies in Tennessee and Kentucky. The District has established seven sampling stations in the lake and one in the tailwater.

An analysis of the water quality data collected to date indicates Lake Barkley does not stratify. In the upper reaches of the lake current velocities generate sufficient turbulence to prevent stratification. By the time the water reaches the lower portion of the lake, where velocities are much lower, it has been exposed to atmospheric conditions for several days and, like the surface layers, is near equilibrium temperature. This factor and the low storage volume versus flow relationship insures fairly uniform temperatures in depth profiles.

The District's sampling program has revealed only one water quality problem of concern. During one of the sampling trips dissolved oxygen concentrations at station 3BAR10005 (near the middle of the lake) were found to be below 5 mg/l from surface to bottom. The cause of this oxygen sag is not known.

The District's water quality data base for Lake Barkley is generally poor. However, before the present sampling program is revised, a detailed survey of data available from other agencies will be made. These data will be analyzed to determine specific problems and outline areas in which more data are needed. The District's sampling program will be designed to fill in the gaps in the existing data base and to define the extent and causes of water quality problems. Once sufficient amount of data has been collected, means of alleviating the problems will be studied.

Water Quality Summary

Cave Run Lake

The water quality of Cave Run Lake is monitored monthly by the Corps. From spring through fall, temperature profiles are taken weekly near the dam.

Influent water quality is generally good, but does show some effect of the strip mining activities in the basin; total iron concentrations during 1975 at the main inflow sampling station average 2,013 ug/1 and tubidity also was occasionally high. Oil and gas wells in the upper part of the basin produced no discernible effect on water quality. The only major point sources, sewage treatment plants at West Liberty and Salyersville, are so far above the lake that their effect on lake water quality is also negligible.

Thermal stratification probably has the greatest impact on lake water quality. In 1975 stratification began about the last week in April and reached a maximum around the first of July, with a temperature difference from top to bottom of 36.5 degrees F. (88 to 51.50 degrees in 60 feet). During most of the summer the epilimnion was 10 to 20 feet deep.

Surface temperatures began a gradual decline about the first of September; however, stratification was very evident and clearly defined up through the first week in October, The lake was completely distratified by the end of October.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer the dissolved oxygen remained near saturation from the surface to a depth of 10 to 20 feet, corresponding to the depth of the epilimnion created by thermal stratification. Near the bottom, the dissolved oxygen was practically zero, until thermal destratification began.

The reducing environment produced in the oxygen depleted hypolimnion caused iron and manganese to be reduced to soluble ionic species. During most of the summer, dissolved iron and manganese in the hypolimnion were present above EPA recommended limits for drinking water, reaching 10,000 ug/l and 3,000 ug/l, respectively. No health hazard was involved and since there are no water supply intakes in the lake, increased iron and manganese did not cause problems in the lake itself. However, it was necessary to release hypolimnetic waters during the summer, and these releases did create problems at the Morehead water treatment plant. Excessive dissolved manganese reached the treatment plant intake about one (1) mile below the damsite. Modifications were made in operational procedure at the dam and at the water supply facility in an effort to remedy the problem. These modifications were not completely effective and the Corps of Engineers is currently studying feasible structural modifications to the outlet works that could eliminate the necessity for releasing hypolimnetic waters.

Nuisance algae blooms have not been a problem in Cave Run Lake. Dissolved phosphorus in the euphotic zone did not reach concentrations which would encourage such nuisance growths during 1975. The average Secchi disc reading for the summer was 88 inches.

Water Quality Summary

Nolin River Lake

The water quality of Nolin River Lake is monitored monthly by the Corps. From spring through fall, temperature profiles are taken weekly near the dam.

Influent water is of relatively good quality. Agricultural activities have had the most influence on water quality; total phosphorus concentration at the main inflow sampling average 148 ug/l during 1975. Total iron concentrations were also high (average of 1,040 ug/l), probably from natural causes. The only important point sources in the basin are the sewage treatment plants at Elizabethtown and Hodgenville, which are far enough upstream from the lake that their effects are minimal.

Thermal stratification probably has the greatest impact on lake water quality. In 1975 stratification began about the first of May and reached a maximum around the end of June, with a temperature difference from top to bottom of 31.1 degrees F. (87 to 55.9 degrees in 95 feet). During most of the summer the epilimnion was 10 to 20 feet deep.

Surface temperature began to decline after the middle of September, but stratification was well defined up until the end of September when a decrease in intensity of stratification became evident. The lake was essentially destratified by the end of October.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer the dissolved oxygen remained near saturation from the surface to a depth of approximately 15 feet, corresponding to the depth of the epilimnion created by thermal stratification. The dissolved oxygen in the hypolimnion gradually declined until, during July and August, the concentration below 25 feet was essentially zero. The lake remained stratified with respect to dissolved oxygen until the middle of November.

The reducing environment produced in the oxygen depleted hypilimnion caused iron and manganese to be reduced to soluble ionic species. During most of the summer, dissolved iron and manganese in the hypolimnion were present at concentrations above EPA recommended limits for drinking water, reaching 3,740 ug/l and 2,700 ug/l, respectively. No health hazard was involved and since the lake is not used as a source of raw water, the increased iron and manganese did not interfere with project purposes. Occasionally, temporary releases of bottom waters were necessary during summer drawdown, but produced no major problems.

Nuisance algae blooms have not been a problem in Nolin River Lake, even though dissolved phosphorus in the euphotic zone did reach concentrations which could encourage such nuisance growths during 1975. The average Secchi disc reading for the summer was 50 inches.

Water Quality Summary

Barren River Lake

The water quality of Barren River Lake is monitored monthly by the Corps. From spring through fall, temperature profiles are taken weekly near the dam.

Influent water quality is generally acceptable with the exception of Beaver Creek. Beaver Creek receives the effluent from the Glasgow sewage treatment plant, which contributes excessive organic materials and nutrients to that arm of the lake. The deleterious effects (low dissolved oxygen, algae blooms, odors, etc.) were confined to the Beaver Creek arm of the lake during 1975. Numerous oil wells in the upper part of the basin have produced no discernible effects on water quality.

Thermal stratification began to form in the last week of April and reached a maximum around the end of August, with a temperature difference from top to bottom of 28 degrees (84 degrees to 56 degrees in 64 feet). During most of the summer the epilimnion was 15 to 20 feet deep.

Surface temperatures began to decrease around the middle of September, at which time stratification also began to decrease in intensity. Destratification was complete by the middle of October.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer of 1975 the dissolved oxygen remained near saturation from the surface to a depth of 15 to 20 feet, corresponding to the depth of the epilimnion formed by thermal stratification. Below 30 feet the dissolved oxygen was practically zero until thermal destratification began.

The reducing environment produced in the oxygen depleted hypolimnion caused iron and manganese to be reduced to soluble ionic species. As stratification became more intense during the latter part of the summer, dissolved iron and manganese in the hypolimnion increased above the EPA recommended limits for drinking water, reaching concentrations of 2,550 ug/l and 3,860 ug/l, respectively, in August. No health hazard was involved and the increased iron and manganese did not interfere with project purposes.

Occasionally temporary releases of bottom waters were necessary during summer drawdown, but produced no major problems. Bowling Green takes raw water from the Barren River about 40 miles downstream. The water treatment plant is notified whenever it is necessary to release hypolimnetic waters and is able to make adjustments to correct for any increased iron or manganese.

Nuisance algae blooms were not a problem during 1975 except in the Beaver Creek arm of the lake. Dissolved phosphorus in the euphotic zone did not reach concentrations which would encourage nuisance growths. The average Secchi disc reading for the summer was 70 inches.

Water Quality Summary

Buckhorn Lake

The water quality of Buckhorn Lake is monitored monthly by the Corps. During the warm part of the year, temperature profiles are taken weekly near the dam.

Influent water quality is acceptable, but has been altered sone-what from natural conditions; apparently strip mining at the basin has caused an increase in influent concentrations of iron and manganese, sulfate, and turbidity. This deterioration in quality has not seriously affected the quality of lake water. The only important point source in the basin is the Hyden sewage treatment plant. By-passes of sewage from this point have been responsible for isolated algae blooms in the headwater area of the lake.

Thermal stratification probably has the greatest impact on lake river quality. In 1975, stratification began about the middle of April and reached a maximum around the end of July with a temperature difference from top to bottom of 24 degrees (84 to 60 degrees). During most of the summer the epilimnion was 10 feet to 15 feet deep.

Surface temperatures began to decrease significantly after the middle of September; there was a 20-degree drop between 18 September and 2 October. Stratification also began to decrease in intensity at this time. The lake was destratified by 23 October with a fairly uniform temperature of 59 to 60 degrees from top to bottom.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer of 1975, the dissolved oxygen remained near saturation from the surface to the depth of the epilimnion created by thermal stratification. Below 30 feet, the dissolved oxygen was practically zero until thermal destratification began.

The reducing environment produced in the oxygen depleted hypolimnion caused iron and manganese to be reduced to soluble ionic species. As stratification became more intense during the latter part of July, dissolved iron and manganese in the hypolimnion increased above EPA recommended limits for drinking water. During September, both metals exceeded the recommended limits at depths below 18 feet and reached maximum concentrations of 3,400 ug/l and 2,100 ug/l, respectively, near the bottom. No health hazard was involved and since the lake is not used as a source of raw water, the increased iron and manganese did not interfere with project purposes. Occasionally, temporary releases of bottom waters were necessary during summer drawdowns, but produced no major problems.

Nuisance algae blooms were not a problem except below the Hyden treatment plant. Dissolved phosphorus in the euphotic zone did not reach concentration which would encourage nuisance growth during 1975. The average Secchi disc reading for the summer was 63 inches.

Water Quality Summary

Green River Lake

The water quality of Green River Lake is monitored monthly by the Corps. From spring through fall, temperature profiles are taken weekly near the dam.

Influent water quality is excellent and appears to have been only slightly altered from natural conditions. The only important point source in the basin is the Liberty sewage treatment plant, which has a very negligible effect on lake water quality.

Thermal stratification has the greatest impact on lake water quality. In 1975, stratification began about the third week in April and reached a maximum around the first of July, with a temperature difference from top to bottom of 31 degrees F. (82 degrees to 51 degrees in 75 feet). During most of the summer the epilimnion was 15 feet to 20 feet deep.

Surface temperature began to decrease significantly after the middle of September and the lake was essentially destratified by the end of October.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer of 1975, the dissolved oxygen remained near saturation from the surface to a depth of 10 feet to 20 feet, corresponding to the depth of the epilimnion created by thermal stratification. Dissolved oxygen concentrations in the hypolimnion gradually decreased over the summer until, by the first of September, the concentration in depths below 30 feet was essentially zero. Low dissolved oxygen concentrations near the bottom continued through October.

The reducing environment produced in the oxygen depleted hypolimnion caused iron and manganese to be reduced to soluble ionic species. During the latter part of the summer, dissolved iron and manganese in the hypolimnion increased above EPA recommended limits for drinking water. During September and October, both metals exceeded the recommended limits at depths below 20 feet and reached maximum concentrations of 3,500 ug/l and 7,700 ug/l, respectively, near the bottom. No health hazard was involved and since the lake is not used as a source of raw water, the increased iron and manganese did not interfere with project purposes. Occasionally, temporary releases of bottom waters were necessary during summer drawdown, but produced no major problems.

Nuisance algae blooms have not been a problem in Green River Lake. Dissolved phosphorus in the euphotic zone did not reach concentrations which would encourage such nuisance growths during 1975. The average Secchi disc reading for the summer was 116 inches.

Water Quality Summary

Rough River Lake

The water quality of Rough River lake is monitored monthly by the Corps. From spring through fall, temperature profiles are taken weekly near the dam.

Influent water is of relatively good quality. Although agriculture is the main land use of the basin and probably produces the most effect on water quality, nutrient inflow during 1975 was not high. Total phosphorus concentrations at the main inflow sampling station averaged only 34 ug/l. Total iron concentrations were slightly high, averaging 700 ug/l apparently from natural causes. There are no important point sourches in the basin.

Thermal stratification probably has the greatest impact on lake water quality. In 1975, stratification began to form during the last week of April and reached a maximum around the end of July, with a temperature difference from top to bottom of 27 degrees F. (82.5 degrees to 55.5 degrees in 65 feet). During most of the summer the epilimnion was 10 to 16 feet deep.

Surface temperatures began to decrease after the middle of September; intensity of stratification started to decrease during the last week of September and the lake was essentially destratified by the third week of October.

Dissolved oxygen stratification began to develop when temperature stratification began. During most of the summer the dissolved oxygen remained near saturation from the surface to a depth of 10 to 15 feet, corresponding to the depth of the epilimnion created by thermal stratification. Dissolved oxygen concentrations in the hypolimnion decreased rapidly in early summer until, by the middle of June, the concentration in depths below 20 feet was essentially zero. Low dissolved oxygen concentrations near the bottom continued through September.

The reducing environment produced in oxygen depleted hypolimnion caused iron and manganese to be reduced to soluble ionic species. As stratification became more intense, dissolved iron and manganese in the hypolimnion increased above EPA recommended limits for drinking water. During the period of thermal stratification, both metals exceeded the recommended limits at depths below 25 feet and reached maximum concentrations of 4,300 ug/l and 2,700 ug/l, respectively, near the bottom. Leitchfield, which takes its municipal water from the lake, experienced water treatment problems with manganese during June 1975. The water supply intake structure is equipped with three different intake levels and at the time the problem developed, water was being withdrawn through the deepest intake. After the city switched to the most shallow intake, the problem disappeared. No health hazard is involved with iron and manganese. Occasional temporary releases of bottom waters were necessary during summer drawdown, but no major problems were produced downstream.

Nuisance algae blooms have not been a problem in Rough River Lake. Dissolved phosphorus in the euphotic zone did not reach concentrations which would encourage such nuisance growths during 1975. The average Secchi disc reading for the summer was 65 inches.

Dewey Project

Sampling Schedule

The intent was to collect physical-chemical samples at Dewey Project at inflows, the lake and outflows on a monthly basis during the periods of anticipated thermal stratification and at least once during the winter period. No results of biological data collection are presented. In 1974, lake sampling was done at one station near the dam, and in 1975 at this station and others at selected intervals upstream in the lake. These intervals were selected to provide insight into the areal and volumetric extent of hypolmnetic water. Selected inflows and the outflow were sampled on the same frequency as lake stations. Sampling dates for 1975 are shown in Table 5-1 and sampling locations in Figure 5-1.

TABLE 5-1

Water Quality Sampling Schedule for Dewey Project - 1974-1975

Year	J	F	M	A	M	J	J	A	S	O	N	D
1974					X		X	X		X		X
1975	X		X			X		X		X		

Results

A large number of physical and chemical parameters, and moderate volumes of data, have been examined. For purposes of this document, only results pertinent to reservoir regulation or impact assessment will be presented.

Physical-Chemical Results

Temperature

The thermal profiles at Dewey Lake near the dam did not show strong stratification during the summer of 1974,the maximum temperature differential in 30 feet of depth being 11 C° in August. The July profile depicted a "linear" gradient with a total temperature differential of 10 C°. Isothermal conditions developed in October and persisted through the winter. The lake resumed its weak thermal stratification during the summer of 1975.

Temperature profiles mear the dam in 1975 did not show significant thermocline formation, although slight inflections were noted in summer months at depths of 5 to 12 feet. These inflections correlated with inflections or sharp changes in the distribution of dissolved oxygen and suspended materials. The maximum vertical temperature change in the pool in 1975 was 14.6 C° (29.7°C to 16.3 °C) between the surface and the 40-foot level in August.

No multi-level outlet structures exist for blending of waters from various depths in the lake near the dam. As a consequence, discharges must be made from deep within the lake or from the surface.

Dissolved Oxygen

In 1974, dissolved oxygen tended to be higher with depth than was anticipated. Levels of dissolved oxygen did fall to zero or near-zero levels at 20 feet in August; however, by early October concentrations of 5 mg/l or greater had returned to a depth of 30 feet.

The dissolved oxygen distribution was relatively constant throughout the water column in January of 1975.

By the 5th of June (1975) a weak primary oxycline was observed at a depth of about 10 feet. Oxygen values fell from 8.1 to 6.6 mg/l between 10 and 13 feet. A secondary oxycline (general oxygen decreases) occurred 23 to 26 feet. Inflections in the temperature profile were noted at the depths of the oxyclines.

On 26 June, the same feature relative to distribution of dissolved oxygen and temperature was observed. However, the intensity of the oxycline had increased. Oxygen values fell from 9.0 to 2.9 mg/l between 5 and 15 feet. The general oxygen decrease occurred at a depth of 25 feet and extended to the bottom while oxygen values fell from 3.5 to 0.7 mg/l.

On 6 August, a sharp oxycline occurred at a depth of 7 feet. Oxygen fell from 7.3 to 0.2 mg/l between 7 and 12 feet. A thermocline (relatively sharp inflection in temperature distribution) occurred at the same depth.

On 25 August, the same types of conditions that occurred on 6 August were observed in the lake. Sharp decreases in both temperature and dissolved oxygen occurred between depths of 10 and 12 feet. Oxygen values fell from 7.4 to 0.8 mg/l.

The odor of H_2O was severe at the stilling basin during summer in both 1974 and 1975. Dissolved oxygen levels deep in the lake were effectively zero at these times.

Metals

Iron

Total iron was high in hypolimnetic water at Dewey Lake during summer months of both 1974 and 1975. The maximum value observed at the main lake station in 1975 and 15.4 mg/l. Concentrations increased sharply from the depth of temperature inflections of the lake. The values rose drastically in the winter to concentrations varying from 3.0 mg/l at the surface to 20.0 mg/l at the bottom. In light of the facts that dissolved iron concentrations were minimal throughout the period of record and turbidities and suspended solids correlated well with total iron, it is felt that the iron is associated with suspended solids in inflow waters.

Maximum discharge concentrations of total iron reached 6.0 mg/l in July 1974 and 4.9 mg/l in October 1975. Maximum levels of dissolved iron in the pool were 0.2 mg/l in 1974 and 1.9 mg/l in 1975. The maximum discharge concentration in 1975 was 0.23 mg/l and occurred in August.

Levels of total iron in the discharge far exceed desirable limits.

Manganese

Total manganese concentrations at the main lake station in 1974 varied from the minimum detectable limit of 0.02 mg/l to a maximum of 0.41 mg/l. In 1975 the values were 0.02 to 1.59 mg/l. Dissolved manganese ranged from less than 0.02 to 0.39 mg/l in 1974 and 0.02 to 1.59 mg/l in 1975. Both total and dissolved maxima for 1974 occurred at 15 feet on 8 August. The maximum for 1975 occurred at 30 feet on 9 August.

Outflow levels of total manganese ranged from 0.08 to 0.43 mg/l in 1974 and from 0.22 to 0.42 mg/l in 1975. Dissolved manganse was measured only in 1975 and fluctuated from 0.18 to 0.41 mg/l.

Total manganese concentrations in the primary inflow above seasonal pool ranged from 0.1 to 0.55 mg/l in 1974 and from 0.06 to 1.3 mg/l in 1975. Soluble manganese sample analyses were done only in 1975 and concentrations varied from 0.06 to 0.35 mg/l.

These data seem to suggest that manganese, for the most part, enters the project in the dissolved form and exists with little discernable change.

Levels of manganese in the discharge exceed desirable limits.

Mercury

Mercury concentrations in the lake column varied from less than the detectable limit (1 ug/l) in 1974 to 8.2 ug/l. In 1975, values ranged from 1 ug/l to 9.3 ug/l.

Outflow concentrations of mercury exceeded the EPA recommended standard of 5 ug/l in December of 1974 (6.6 ug/l) and in August in 1975 (8.5 ug/l).

Levels in samples at the main inflow station exceeded the standard in December of 1974 (7.2 ug/l, in June 1975 (8.2 ug/l) and August 1975 (7.3 ug/l)

No explanation can be given at this time for the fact that levels of mercury above 5 ug/l were not present in the pool when both inflow and outflow values exceed this level upon occasion.

Because of the known toxicity of this metal of both humans and aquatic life, mercury should continue to be monitored in inflows, the lake and the outflow.

pH and Alkalinity

The range of pH was generally from 6.1 to 8.2, and alkalinity from 17 to 77 mg/l as Ca CO_3. Such results are representative of a low buffering capacity, which is typical for the predominately non-calcareous nature of this watershed. It is anticipated that mining activities currently underway might impact adversely upon this regime of pH values.

Conductivity

Conductivity fell within the range 100 to 250 umho/cm in the pool. Inflow values generally fell within this same range, but reached 380 umho/cm on one occasion during low flow conditions in fall.

Nutrients

Nitrogen

Soluble nitrogen tended toward the organic form during summer throughout the lake. During cold weather nitrogen was divided approximately equally between the organic and nitrate forms.

However, nitrate concentrations rose drastically in January 1975 to a level of about 1.75 mg/l. This high value for nitrate was reflected in the outflow.

Phosphorus

Total phosphorous showed some variation with depth, ranging from maximu surface values of 70 ug/l (as P) in 1974 and 100 ug/l in 1975, to a maximum of 170 ug/l at 20 feet in 1974 and 30 ug/l at 30 feet in June of 1975.

Outflow values tended to mirror lake concentrations. Inflow values ranged from 30 to 1020 ug/l.

It appears that phosphorus may be a limiting nutrient.

Optical Properties of Water and Suspended Materials

Optical properties of water may be evaluated for such limnological purpose as study of stratification, turbidity, particle size distribution of suspended solids and plankton layer depths. Light transmissivity in water is one technique used to evaluate optical properties of this fluid. Measurements are made of effects of suspended materials on a beam of light traveling along a fixed pathway. Light trasmission or attenuation varies in response to transparency of the water.

Instrumentation of the type described above was used to evaluate levels of water transparency (i.e., levels of suspended materials) in the water column at Dewey Lake in 1975. Because of the various performance and readout characteristics of the instrument which was used, it is felt that data is of use only for ascertaining patterns of distribution of suspended material (qualitative evaluations) and not for evaluation of actual concentrations (quantitative evaluations).

Results indicate, as in the case of Fishtrap Lake, that apparent density layering effects occur within the lake.

On 6 August a sharp increase in suspended material occurred at 12 feet, reached a maximum at 17 feet and decreased sharply from 17 to 20 feet. An extremely sharp increase then occurred at 20-22 feet, a high and constant level of suspended material existed between 22 and 37 feet, and levels decreased sharply from 37 feet to the bottom. The depth of the oxycline was immediately above the first suspended solids increase.

On 25 August, a sharp increase in suspended material was observed from 12 to 15 feet and another sharp increase started at 20 to 22 feet. From 22 feet to the bottom the levels were constant and high.

Inspection of profiles taken at selected intervals upstream from the dam add additional support to the density layering concept.

Summary of Results

Excessive sedimentation could be the most significant problem affecting normalized operation and management of the Dewey Lake Project. Coal mining in the project watershed is the primary source of the problem. Preliminary results indicate that inflow of sediment from the watershed to Dewey Lake might be causing turbidity and sedimentation problems which could overshadow effects of most other water quality problems. Apparent density layering effects occur with the pool. These effects are reflected in the distribution of temperature, dissolved oxygen and suspended materials. Relatively high levels of suspended materials occurred below depths of about 20 feet in the summer of 1975.

Levels and iron and manganese are high in the outflow, and the present design of the outflow structures permit only limited blending from near-bottom and surface elevations of the lake. Since levels of total iron correlated well with turbidities and suspended solids, it is felt that iron is associated with suspended solids in inflow waters. High levels of mercury have been measured at the main inflow station and the outflow.

The range of pH (6.1 to 8.2) and low values of alkalinity are representative of a low buffering capacity and are typical for the predominately non-calcareous nature of this watershed. Although no deleterious shifts were noted in either of these parameters, it is anticipated that the pH regime might be adversely impacted by mining activities.

For purposes of the fishery and food chain within the lake, it appears that phosphorus is a limiting nutrient.

When results are considered as a whole, the water quality of the lake is in a poor to degraded state. Continued adverse environmental effects from mining activities can only serve to cause continuance or deterioration of the situation.

Fishtrap Project

Sampling Schedule

The intent was to collect physical-chemical samples at Fishtrap Project at inflows, the lake and outflows on a monthly basis during the periods of anticipated thermal stratification and at least once during the winter period. In 1975, lake sampling was done at one station near the dam and others at selected intervals upstream in the lake. These intervals were selected to provide insight into the areal and volumetric extent of hypolmnetic water. Selected inflows and the outflow were sampled on the same frequency as lake stations. Sampling dates for 1975 are shown in Table 5-1 and sampling locations in Figure 5-1.

TABLE 5-1

Water Quality Sampling Schedule for Fishtrap Project - 1975

1975											
J	F	M	A	M	J	J	A	S	O	N	D
		X		X	X	X	X				

Results

Excessive sedimentation is the most significant problem affecting normalized operation and management of the Fishtrap Lake Project. Coal mining in the project watershed, both on and off Federal lands, is the primary source of the problem. Excessive sedimentation has resulted in both loss of lake storage and degradation of recreational usage and development potential.

Inflow of sediment from the watershed to Fishtrap Lake causes turbidity and sedimentation problems which overshadow effects of most other water quality problems.

A large number of physical and chemical parameters, and moderate volumes of data, have been examined. For purposes of this document, only results pertinent to reservoir regulation or impact assessment will be presented.

Physical-Chemical Results

Temperature

Temperature profiles near the dam did not show significant thermocline formation in 1975, although slight inflections were noted in summer months at depths of 15-20 feet, 30 and 45 feet and near the bottom.

These inflections correlated with inflections or sharp changes in the distribution of dissolved oxygen and suspended materials. Maximum vertical temperature change in the pool was 13.5°C (29.2°C to 15.7°C) between surface and the 15-foot levels, respectivel, in July.

Multi-leve outlet structures permitted blending of waters from various depths in the lake near the dam. As a consequence of this blending ability, moderate success was achieved in meeting downstream temperature criteria established by agreement and a cooperative effort between the Corps of Engineers and the State of Kentucky for a cold water fishery.

Dissolved Oxygen

The dissolved oxygen distribution was relatively constant throughout the water column in March, May and June.

In July, a primary oxygen maximum was observed at a depth of 10 feet. Secondary maxima were observed at depths of 32 feet, 42 and 62 feet. Below a depth of 20 feet, a curve of slowly decreasing values toward the bottom occurred. The primary maximum may be attributable to phytoplankton oxygen production. The secondary maximum may have resulted from effects of density layering, as a 4°C! temperature difference occurred between depths of 35 to 37.5 feet and significant decreases in water clarity occurred between 40 to 45 feet.

In August, the dissolved oxygen concentration was nearly uniform at about 8.5 mg/l from the surface down to 17 feet. At that depth, a strong oxycline formed. Values dropped to 3.5 mg/l over a 5-foot interval and concentrations steadily decreased to effectively zero at 35 feet. A secondary maximum (concentrations up to 1.5 mg/l) started at about 47 feet and extended to the bottom. This increase corresponded to a slight temperature inflection at 45-50 feet and a significant decrease in water clarity that started at about 45 feet. Again, this secondary maximum may have resulted from effects of density layering.

Metals

Iron

Concentrations of iron at the main lake station in 1975 ranged from 0.08 to 2.0 mg/l with a mean of 0.96 mg/l. for total iron. Dissolved iron was determined on four occasions and never exceed the minimum detectible limit of 0.10 mg/l.

Maximum discharge concentrations reached 2.12 mg/l in 1974 and 12.80 mg/l in 1974-75. Dissolved iron concentrations, however, were never higher than the minimum detectable limit of 0.10 mg/l.

Inflow concentrations of total iron ranged from 0.71 to 32.25 mg/l and from 1.04 to 3.91 mg/l in Levisa Fork. The soluble iron concentration for 1974-1975 was never above the 0.10 mg/l detectable limit.

This data seems to suggest that iron enters the pool in the suspended state and moves through or settles out without being converted to a soluble form.

Manganese

Total manganese concentrations at the main lake station in 1975 varied from the minimum detectable limit of 0.02 to 0.97 mg/l with a mean of 0.17 mg/l. Dissolved manganese ranged from less than 0.02 to 0.83 mg/I with a mean of 0.13 mg/l.

Outflow levels of total manganese ranged from 0.09 to 0.68 mg/l in 1974 and from 0.06 to 0.76 mg/l in 1975. Dissolved manganese was only determined in 1975 and fluctuated from 0.06 and 0.68 mg/l with a mean of 0.25 mg/l.

Total manganese concentrations in Levisa Fork above seasonal pool ranged from 0.01 to 1.20 mg/l in 1974 and from 0.11 to 0.20 mg/l in 1975. Soluable manganese sample analyses were done only in 1975; concentrations varied from 0.05 to 0.20 mg/l with a mean of 0.10 mg/l.

These data seem to suggest that manganese, for the most part, enters the project in the dissolved form and exist with little discernable change.

Mercury

Mercury concentrations in the lake column did not exceed the 5mg/l standard in 1975. Values ranged from 1.0 to 4.9 ug/l, with a mean of 2.5 ug/l.

Outflow concentrations of mercury exceeded the standard in June and August of 1974 and January of 1975 (values were 6.7, 5.2, and 6.9 mg/l, respectively).

Concentrations in samples from Levisa Fork above the pool in 1974 were excessive on only one occasion (June), having a concentration of 7.5 ug/l. In 1975, the January and May samples contained 7.6 and 5.8 ug/l mercury respectively.

No explanation can be given for the lack of concentrations of mercury above 5ug/l in the pool when both inflow and outflow values exceed this upon occasion.

pH and Alkalinity

For 1975 at the main lake station, values of pH in the water column ranged from 6.1 to 8.1 with a mean of 7.0 and alkalinity values ranged from 23 to 59 mg/l as CaCO3 with a mean of 32 mg/l. Such results are representative of a low buffering capacity and are typical for the predominantly non-calcareous nature of this watershed.

Values of pH in the inflows for 1974 ranged from 7.0 to 8.1 mg/l and 1975 from 6.9 to 7.6 mg/l. Total alkalinity values ranged from 31 to 86 mg/l as CaCO3 in 1974 and from 17 to 82 mg/l as CaCO3 in 1975. No trends relative to water quality of inflowing streams could be found. It is possible, however, that mining activities currently underway in the watershed might impact adversely on the regime of pH in both inflowing water and the lake. Accordingly, future monitoring programs will include comprehensive pH studies at both inflow and lake stations.

Conductivity

Conductivity values in the water column of the pool at the primary lake station near the dam were somewhat high in 1975 and ranged from 200 to 500 micro mho/cm with a mean of 305.

Considerably higher conductivity values were found at the inflow, although the range was variable and wide (50 to 850 umho/cm in 1974 and 155 to 660 umho/cm in 1975). Future monitoring programs will include comprehensive conductivity studies at both inflow and lake stations.

Nutrients

Nitrogen

Kjeldahl nitrogen at the main lake station ranged from 0.10 to 0.20 mg/l with a mean of 0.13 mg/l in 1975. Nitrate plus nitrite ranged from 0.1 to 0.9 with a mean of 0.47 mg/l. Kjeldahl at the outflow in 1974 ranged from 0.1 to 0.4 mg/l and from 0.1 to 0.6 mg/l in 1975. Nitrate plus nitrite values ranged from 0.3 to 1.2 mg/l and from 0.2 to 1.7 mg/l in 1974 and 1975, respectively. At the inflow, nitrate-nitrite values ranged from 0.2 to 0.9 and from 0.1 to 0.5 mg/l in 74-75, respectively. Kjeldahl values ranged from 0.2 to 0.9 mg/l at the inflow in 1974 and from 0.1 to 0.5 in 1975. Highest values of nitrate-nitrite recorded in the inflows, the lake and the outflow occurred in the December-January period of 1974-1975. No trends are apparent in the data.

Phosphorus

The most important trend at the main lake station near the dam was that dissolved phosphorus exceeded the minimum detectable limit of our analysis on only one occasion at only one depth. Total phosphorus ranged from 10 to 80 ug/l in 1975 and soluable phosphorus from 10 to 30 ug/l. Total phosphorus in the outflow ranged from 10-85 ug/l and 10-140 ug/l in 1974 and 1975, respectively. Dissolved varied from 10 to 10 ug/l in 1975 (no data collected in 1974).

Total phosphorus in the inflow ranged from 40 to 780 ug/l in 1974 and from 50 to 105 ug/l in 1975; soluble phosphorus from 10 to 40 ug/l in '75 (no data collected in 1974).

It appears that phosphorus is productivity limiting in Fishtrap Lake.

Optical Properties of Water and Solids

Optical properties of water may be evaluated for such limnological purposes as study of stratification, turbidity, particle size distribution of suspended solids and plankton layer depths. Light transmissivity in water is one technique used to evaluate optical properties of this fluid. Measurements are made of effects of suspended materials on a beam of light traveling along a fixed pathway. Light transmission or attenuation varies in response to transparency of the water.

Instrumentation of the type described above was used to collect *in situ* data at Fishtrap Lake. Because of the various performance and readout characteristics of the instrument, it is felt that data is of use only for ascertaining patterns of distribution of suspended material (qualitative evaluations) and not for evaluation of actual concentrations (quantitative evaluations).

In the summer months (June, July and August), near the dam, apparent effects of density layering (increased levels of suspended materials) were noted at depths of 15-20 feet, 30 to 45 feet and near the bottom. Variations in distribution of temperature and dissolved oxygen are noted at the same depths.

Inspection of profiles taken at approximate one-mile intervals upstream from the dam added additional support to the density layering concept. Breaks or inflections in distribution of suspended materials, temperature and dissolved oxygen occur at the same depths. Although the picture is quite complicated, it appears that relatively low-temperature water with relatively high levels of suspended materials in the inflows moves into lower regions of the lake in a density underflow. Other effects are obviously superimposed upon the density layering phenomenon. For example, Secchi depths show a pattern of steadily increasing values from the inflows toward the dam. This indicates settling of suspended materials from upper portions of the water column in the downstream direction in the lake. This is expected because of the decreased velocity regime within the lake as opposed to the inflows.

Summary of Results

Excessive sedimentation is the most significant problem affecting normalized operation and management of the Fishtrap Lake Project. Coal mining in the project watershed is the primary source of the problem. Preliminary results indicate that inflow of sediment from the watershed to the Lake is the cause of turbidity and sedimentation problems which overshadow effects of most other water quality problems.

Apparent density layering effects occur with the pool. These effects are reflected in the distribution of temperature, dissolved oxygen and suspended materials. Relatively high levels of suspended materials occurred in lower layers of the lake in the summer of 1975.

In summary, the water quality at Fishtrap lake is considered as degraded to severely degraded.

Grayson Project

Sampling Schedule

The intent was to collect physical-chemical samples at Grayson Project at inflows, the lake, and outflows on a monthly basis during the periods of anticipated thermal stratification and at least once during the winter period. In 1974, lake sampling was done at one station near the dam and in 1975 at this station and others at selected inervals upstream in the lake. These intervals were selected to provide insight into the areal and volumetric extent of hypolimnetic water. Selected inflows and the outflows were sampled on the same frequency as lake stations.

TABLE-5-1

Water Quality Sampling Schedule for Grayson Project - 1974-1975

	J	F	M	A	M	J	J	A	S	O	N	D
1974				X	X		X	X	X	X	X	X
1975	X			X	X	X	X	X	X			

Results

A large number of physical, chemical, and biological parameters, and large volumes of data have been examined. For purposes of this document, only results pertinent to reservoir regulation or impact assessment will be presented.

Physical-Chemical Results

Temperature

Temperature profiles near the dam followed the classic pattern in Grayson Lake. In 1974, a stable, sharp, thermal gradient was observed in July and destratification occurred in early October. Profiles from mid-October to January of 1975 showed a nearly uniform vertical distribution of temperature. April and May profiles in 1975 were indicative of transition states between isothermal and stratified conditions in the lake. The thermal gradient had developed by early June and destratification occurred in mid-October. The most drastic vertical changes in temperature occurred at levels 10 to 20 feet below the surface during both years.

Multilevel outlet structures permitted blending of waters from various depths in the lake near the dam. As a consequence of this blending ability, moderate success was achieved in meeting downstream temperature criteria established by agreement and a cooperative effort between the Corps of Engineers and the State of Kentucky for a cold-water fishery. Temperature objectives and temperatures actually recorded are presented in Figure 7-1.

Dissolved Oxygen

Dissolved oxygen concentrations in the lake fluctuated from above saturation in the epilimnion to effectively zero in the hypolimnion during summer (stratification) periods. Positions of the thermocline and oxycline were nearly identical. Oxygen destratification occurred at approximately the same time as the fall mixing. Outflow dissolved oxygen was consistently high due to high-level releases from within the reservoir and stilling basin reaeration of the discharged water. Values in 1975 ranged from 8.1 (June) to 11.4 (January) mg/l.

Metals

Iron

Prior to thermal stratification in both 1974 and 1975, total and dissolved iron concentrations at the main lake station were relatively low. After thermocline formation, hypolimnitic concentrations reached 9.75 mg/l total iron and 7.05 mg/l dissolved iron in 1974, and 13.25 mg/l and 7.17 mg/l total and dissolved iron respectively in 1975.

As a result of the high concentrations of total iron in the hypolimnion, maximum discharge concentrations reached 2.45 mg/l in 1974 and 4.54 mg/l in 1975. Dissolved iron concentrations, however, were never higher than 0.20 mg/l, indicating that most dissolved iron quickly precipitated upon contact with the high dissolved oxygen introduced via turbulence in the outlet works. This mechanism formed a reddish-orange coating on the substrate in the stilling basin and inhibited production of benthos as documented by sampling analyses conducted in the outflow area (see 7.2.1).

Inflow concentrations of total iron were highest in Newcombe Creek (31.97 mg/l), the Little Sandy River (7.25 mg/l), and Bruin Creek (5.09 mg/l). The maximum soluble iron concentration for all inflows for 1974-1975 was 0.15 mg/l in the Little Sandy River. This data seems to suggest that iron enters the pool in the suspended state and, after thermocline formation and deoxygenation of the hypolimnion, is mobilized to the dissolved form.

This mechanism of iron transport into and through the project poses a limitation on this agency's ability to provide low tailwater temperatures required to sustain the late summer trout fishery.

Manganese

In both 1974 and 1975 during isothermal conditions, total and dissolved manganese concentrations in the water column at the main lake station were relatively low. During the period that stratified conditions existed epilimnitic concentrations of both forms of manganese were low, while hypolimmitic concentrations reached 5.00 mg/l total manganese and 3.57 mg/l dissolved in 1974. In 1975, the maximum concentration for both total and dissolved was 3.52 mg.1. As expected, results of outflow samples confirmed that concentrations in bottom releases during the stratified period exceeded desirable standards in both 1974 (2.18 mg/l total manganese) and 1975 (1.26 mg/l total and 1.12 mg/l dissolved manganese). This poses another substantial constraint on this agency's ability to meet low temperature tailwater objectives needed to support the downstream cold water fishery during late summer.

Manganese in the discharge from Grayson Lake showed no apparent trends in the 1974-1975 period. Only total manganese data were collected in 1974 and values ranged from 0.12 to 2.18 mg/l. Both total and dissolved data were collected in 1975--total values ranged from 0.05 to 1.26 mg.1 and dissolved values from 0.02 to 1.12 mg/l.

While insufficient samples were collected and analyzed from the tributaries to Grayson Lake to determine actual patterns in inflowing concentrations of total and dissolved manganese, the data collected suggests that Little Sandy River contributes the largest quantity of total manganese to the lake, while Newcombe Creek has the highest actual concentrations of dissolved manganese.

Mercury

While mercury concentrations exceeded 5.0 mg/l in the entire lake column at the main lake station during 1974, this value was exceeded on only one occasion in 1975 (January bottom sample from 40 feet). Concentrations exceeded the standard on two occasions in 1974 and on occasion in 1975.

Insufficient inflow sampling for mercury during 1974 makes determination of any trends impossible. In 1975, however, every inflow to Grayson Lake sampled for mercury exceeded the standard on at least one occasion.

pH and Alkalinity

For 1974 and 1975 at the main lake station, values of pH in the water column ranged from 6.1 to 7.9 and total alkalinity values ranged from 4.9 to 41 mg/l as $CaCO_3$. Such results are representative of a low buffering capacity and are typical for the predominantly noncalcareous nature of this watershed.

Values of pH in the inflows for 1974 and 1975 ranged from 6.0 to 8.5 and total alkalinity values ranged from 9 to 73 mg/l as $CaCO_3$. No trends relative to water quality of inflowing streams could be found. It is anticipated, however, that mining activities currently underway in the watershed might impact adversely on the regime of pH in both inflowing water and the lake. Accordingly, future monitoring programs will include comprehensive pH studies at both inflow and lake stations.

Conductivity

Conductivity values in the water column of the pool at the primary lake station near the dam were relatively low in both 1974 and 1975 and ranged from 70 to 170 micro mho/cm.

Solids

Total suspended solids in the main lake station near the dam ranged from the minimum limit of sensitivity to 86 mg/l in the water column during the 1974-1975 period. Outflow values ranged from less than 5 to 18 mg/l. These results indicate, as expected, that the project is acting as a sediment trap.

Although only limited solids data is available for most of the inflow stations, certain trends are indicated from inspection of the information.

Levels of total suspended solids in the inflows were variable among stations and exhibited a wide range. Highest values recorded were at Little Sandy River (184 mg/l), Newcombe Creek (874 mg/l), and Bruin Creek (114 mg/l). The highest value recorded at Clifty Creek was 21 mg/l and at Deer Creek the minimum limit of sensitivity (5 mg/l) was never exceeded.

Two interesting observations emerged. First, the relatively high level of suspended solids at Newcombe Creek and the excessively high level at Bruin Creek correlate well with results of benthic invertebrate analysis, which indicate degraded water quality for these streams. Second, the fraction of total volatile solids (10 and 99 mg/l) at Newcombe Creek is very high when compared to total suspended solids (18 and 114 mg/l). It is concluded, therefore, that a large proportion of the suspended solids is composed of volatile (combustible) substances such as coal. District personnel have, in fact, observed significant quantities of coal in the stream bed during periods of low flow.

Benthos

Benthic macroinvertebrates in a stream relect both conditions at the time of sampling and the history of the quality of the aquatic environment for several months prior to their collection. These organisms are not highly mobile and are able to rapidly migrate from an area undergoing sever degradation. Consequently, certain species serve as indicators of degraded conditions resulting grom moderate to severe pollution over extended periods of time, while others are indicators of a continuing high quality environment with excellent water quality.

A synopsis of results of benthic macroinvertebrate analyses is presented in Table 7-2. Additional information and suggested causes of water quality are given in the following paragraphs.

Insufficient benthic data was available from the Little Sandy River inflow to determine any trends relative to time. Moderate diversity accompanied by a relatively high equitability indicates that the environment at this station is not favorable enough for a diverse benthic macroinvertebrate community to inhabit the area. This conclusion is further supported by the low density documented to exist at this station. Data suggest that the size of the gravel substrate is the factor limiting the fauna present at this station.

While one benthic sample from the Middle Fork inflow does not provide enough base line data to make any definite conclusions about the fauna at this station, certain trends seem to be indicated. Low density, moderate diversity, and very high equitability indicate slight degradation at this station. Even though an active strip mining operation utilizes the highway paralleling Left Fork, which is a tributary to Middle Fork, effects on the benthos were not greatly pronounced at our sampling station.

Benthos sampling at the Newcombe Creek station was not extensive enough to allow any projections of limiting parameters. However, because of the extremely low density, diversity, and equitability, it was apparent that the fauna at this station is severely limited by some water quality parameter or parameters, probably associated with inactive strip mining operations upstream of the sampling station.

Data from the Bruin Creek inflow station are indicative of a degraded environment. Again, mining activities are indicated as the cause.

TABLE 7-2

Synopsis of Benthic Data Used as Long-term Indicators of Water Quality at Grayson Project[1]

Station	Insufficient No. Samples	Density[2]	Diversity[2]	Equitability[3]	Evaluation of Water Quality
Little Sandy River Inflow		Low	Moderate	Moderate	Fair
Middle Fork Inflow	**	Low	Moderate	High	Fair
Newcombe Creek Inflow		Low	Low	Low	Degraded
Bruin Creek Inflow		High	Moderate	Low	Degraded
Far Clifty Creek		Moderate	High	High	Good
Deer Creek	**	Low	High	High	Fair
Outflow		Low	Low	Low	Degraded

1 Further clarification of the results drawn from this table is presented in the test.

2 Evaluation of these parameters is arbitrarily established as low, moderate, or high.

3 Evaluation of water quality is arbitrarily established as degraded, fair, or good.

Diversity and equitability values for benthos at Far Clifty Creek indicate good water quality. No limiting parameters are apparent. Even though this station is downstream of an active strip mine site, the fauna shows no indication of degradation. Inspection of the mining site by District personnel at the time of sampling indicated proper operational controls were being exercised by the mining firm involved. Results of the data obviously indicate that such controls cann be effective in reducing environmental degradation.

While more data will be necessary to form a complete picture at the Deer Creek station, initial results show the benthos at this station to be highly diverse although present in only moderate numbers. Dominance of intolerant forms, high diversity, and high equitability indicated good water quality with no apparent degradation.

The very low total number of benthic organisms recovered in the outflow, low diversity, and moderate equitability indicated a degraded environment. Of the total fauna present at this station, 75 percent were sessible organisms relying on plancton for nutrition. This data indicates that substantial concentrations of planktors are contained in Grayson's discharge.

While plankton discharged from the project should provide a nutrient base for benthic macroinvertebrates (i.e., filter feeding triopterans and dipterans) preliminary samples collected in the stilling basin suggests that no such development has occurred due to chemical characteristics of discharged water. At some point below the project where available oxygen has precipitated most heavy metals, this fauna should develop, offering an excellent food source for forage fish necessary for a self-sustaining downstream fishery.

Plankton

Insufficient plankton data are available to permit interpretation.

Summary of Results

Temperature profiles near the dam followed the classic pattern in Grayson Lake. In 1974 a stable, sharp, thermal gradient was observed in summer months and de-stratification occurred in fall. Winter profiles showed a nearly uniform vertical distribution of temperature. Late winter and early spring results were indicative of transition states between isothermal and stratified conditions in the lake.

Dissolved oxygen concentrations in the lake fluctuated from above saturation in the epilimnion to effectively zero in the hypolimnion during summer (stratification) periods. Positions of the thermocline and oxycline were nearly identical. Oxygen de-stratification occurred at approximately the same time as fall mixing. Outflow dissolved oxygen was consistently high due to high-level releases from within the reservoir and stilling basin reaeration of the discharged water.

Multi-level outlet structures permitted blending of waters from various depths in the lake near the dam. As a consequence of this blending ability, moderate success was achieved in meeting downstream temperature criteria established by agreement and a cooperative effort between the Corps of Engineers and the State of Kentucky for a cold-water fishery.

However, concentrations of iron and manganese were high in hypolemnetic waters during periods of stratification and imposed constraints on meeting temperature objectives.

Levels of mercury in excess of 5.0 ug/l have been measured in both the inflow and outflow of the lake.

Relatively low values of alkalinity, and the range of pH observed during the study period, are representative of a low buffering capacity and are typical for the preliminately non-calcareous nature of the watershed.

Conductivity values in the water column of the pool at the primary lake station near the dam were relatively low. Considerably higher conductivity values were found at certain of the inflows, although the range was variable and wide at these stations.

Total suspended solids in the main lake station near the dam and from the outflow, were relatively low. Levels of total suspended solids in the inflows were variable among stations and exhibitied a wide range.

It appears that phosphorus is productivity limiting.

Results of biological sampling indicate that degraded environments exist at inflow stations on Newcombe and Bruin Creeks. These results are supported by conductivity and suspended solids data. Fair to good environments occurred at other inflow stations.

Biological results also indicate a degraded environment at the outflow during the periods of sampling and that substantial concentrations of planktors are contained in the discharged water. While plankton discharged from the project should provide a nutrient base for benthic macroinvertebrates preliminary samples collected in the stilling basin suggests that no such development has occurred due to chemical characteristics of discharged water. At some point below the project where available oxygen has precipitated most heavy metals this fauna should develop, offering an excellent food source for forage fish necessary for a self sustaining downstream fishery.

In summary, the overall water quality of Grayson project is fair to good. It is anticipated, however, that mining activities currently underway in the watershed might impact adversely on this regime of water quality both in inflowing water and the lake. Accordingly, future monitoring programs must include focused studies at both inflow and lake stations, and cooperative studies and regulatory effort with the State of Kentucky and other appropriate agencies.